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MODIFICATION TO MATH MODEL FOR SMALL INDEPENDENT ACTION FORCES (SIAF)

TRW Systems Group

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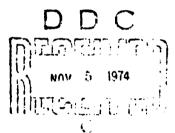
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MODIFICATION TO MATH MODEL FOR SMALL INDEPENDENT ACTION FORCES (SIAF) FINAL REPORT

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MODIFICATION TO MATH MODEL FOR SMALL INDEPENDENT ACTION FORCES (SIAF) FINAL REPORT

INTRODUCTION

This document, prepared by TRW Systems Group, One Space Park, Redondo Beach, California, constitutes the final technical report on the "Modification to Math Model for SIAF" program. This program was conducted under ARPA/AMICOM Contract Number DAAHO1-73-C-0914 during the period 25 May 1973 to 31 December 1973. The original study sponsor was the USACDC Systems Analysis Group. Shortly after the start of the work, cognizance was transferred to the U. S. Army Infantry School. The principal product of this program was a revision to a computerized simulation model of a SIAF operating in both reconnaissances and combat modes developed by TRW under previous ARPA contracts.

The SIAF simulation model is provided as computer software installed on the CDC 6500 computer at Fort Leavenworth, Kansas, and additions to and replacements for a six-volume User's Manual as follows:

Volume I-Model Description and Programming Guide (This Final Report serves as a forward to Volume I)

Volume II-Model Subroutines (Terrain, Weather, Targets)

Volume III-Model Subroutines (SIAF Function and Ancillary Routines)

Volume IV-Model Program Listing

Volume V-Combat Initialization Subroutines

Volume VI-Combat Execution Subroutines

These six volumes are to be considered as part of the final report.

This final report provides a background to the SIAF program, a brief description of the features of the integrated SIAF model, and a summary of the tasks performed during the current contract.

Section 2 of Volume I provides a more complete overview of the SIAF model. Full details of the individual submodels are provided in Volumes II through VI.

BACKGROUND

In recognition of the increasing importance and complexity of small military patrols in low intensity guerilla warfare, ARPA activated the Small Independent Action Forces (SIAF) program in 1968. This continued project has as its ultimate objective the improvement of the operational effectiveness of SIAF units. One aspect of this objective has been the need to develop a rapid and economical means of measuring patrol effectiveness to permit the effects of postulated improvements or changes to be evaluated. Namely, a capability is required to

- ° Study effects of changes in equipment
- Establish tradeoffs for organization/equipment mixes
- Expose alternative doctrine options

In furtherance of this objective, ARPA has snonsored several types of research and development programs. These have included the collection of extensive field data on the various aspects of patrol operations in Southeast Asia, equipment development programs, field test programs, and a SIAF computer model simulation program by TRW Systems. The model is the subject of this report.

The SIAF simulation model has been developed by TRW Systems under seven successive programs. The first, under ARPA/AMICOM Contract DAAHO1-70-C-0141 running from August 1969 to June 1970, was to determine the feasibility of structuring a SIAF model for use as an evaluation tool. The second, under ARPA/AMICOM Contract DAAHO1-71-C-0100 running from August 1970 to August 1971 was to develop a computerized simulation of a SIAF patrol in a reconnaissance role. The primary effort was formulation and programming of the model itself. Volumes II and III of the SIAF Users Manual describe primarily the results of that effort.

The third TRW SIAF program was the SIAF External Fire Support Study, under ARPA/AMICOM Contract DAAHOl-/1-C-1115 running from May 1971 to May 1972. An output of that study was an External Fire Support Submodel that was incorporated into the SIAF Reconnaissance Model.

The fourth SIAF model development program provided for the development and programming of a fully computerized stochastic combat submodel

which provided dynamic deployment logic as well as fully simulated small arms fire. This work was performed under ARPA/AMICOM Contract DAAHO1-72-C-0305 running from November 1971 to December 1972. The results were fully integrated with the previous SIAF Reconnaissance Model.

Two subsequent contracts, DAAHO1-73-C-0222 and DAAHO1-73-C-0257 which were performed in December 1972 and from March 1973 to July 1973, respectively, were used to reprogram the SIAF model to run on the CDC 6500 computer.

The final SIAF model development contract was used to modify the SIAF Model. This has been performed under Contract DAAHO1-73-C-0914 from June 1973 to December 1973. The work performed is the subject of this report.

MODEL SUMMARY

The Small Independent Action Forces (SIAF) Model is a computer simulation intended for use in evaluating the effectiveness of alternative SIAF concepts. The model essentially accepts as input a military operations plan, such as would be prepared by a military commander in the field for an actual patrol operation, and simulates this operation on a computer. It considers both reconnaissance and combat missions. The SIAF Model simulates the interactions of the operations plan with the terrain, weather, and enemy situation. It considers a total mission from beginning to end. The output of the model is the effectiveness of the particular operation under consideration. During the simulation of activities and events which occur during SIAF operations, the model calculates statistics pertaining to movement, navigation, surveillance and detection, fire support, supply maintenance, human maintenance, communications, and casualties.

The model is checked out and is ready for use. It can be applied to a variety of problems involving the effectiveness of SIAF operations, such as the effects of postulated improvements and determination of performance capabilities of these type units. It can also be used to study the sensitivities with respect to numerous input variables.

Listed below are some of the features of the SIAF model compared to other models which might be used for the same purpose:

- 1) It simulates the entire mission from start to finish and is capable of considering up to 10-day missions. This differs from many existing models of patrol operation which consider only a partial mission segment. The functions of movement, navigation, surveillance and detection, fire support, supply maintenance, human maintenance and external communications and their interactions are explicitly considered in the model.
- 2) It includes a detailed and realistic treatment of terrain considering relief, vegetation, obstacles, cultural features and surface material. This differs from other existing models in that for this model relief is represented by a continuous surface, and vegetation is represented throughout the entire area of operations instead of just locally.
- 3) It has an explicit detailed treatment of visual detection considering instantaneous locations of each SIAF and target individual as well as light level, reflectivity and background.
- 4) It includes dynamic movement of the patrol and detailed target movement. The patrols can advance toward targets or can be made to move around them.
- 5) The suppressive effect of incoming fire is considered for both movement and outgoing fire.

The combat model has the following detailed features:

- It considers the events and conditions just prior to entering combat as well as the combat itself. Thus allowing study of the effect of pre-combat conditions and of entry into and exit from combat.
- 2) It considers ambush, attack, defense and meeting engagements.
- 3) It is stochastic and considers the attributes of each man on both sides. It considers individual fire-target combinations.

- 4) It relates the progress and the outcome of combat operations to environmental variables such as terrain, weather, etc., as well as to the combat power on each side.
- 5) It allows a study of combat alone or combat in combination with reconnaissance and/or in combination with the complete SIAF mission.
- 6) It considers EFS and organic weapon combat.
- 7) It allows user-input to many of the variables and decision factors so as to study the effect of variations of these.

SUMMARY OF ACTIVITY

Technical Objective

The objective of Contract DAAHO1-73-C-0914 "Modification to Math Model for Small Independent Action Forces", is to improve the capability and utility of the previously developed SIAF model.

Technical Requirements

This section discusses each of the requirements specified in Technical Requirement Number 1816, which is an attachment to the contract.

- 1.0 <u>Digital Elevation Data</u> The SIAF model now has the capability to use digital elevation data from tapes provided by the Defense Mapping Agency. Using subroutines created by the Systems Analyses Group of USACDC, a TOPOCOM tape is unpacked and a disk file is created for the area of operations. This disk file contains elevation data at the maximum resolution. When the SIAF model is run, the elevation data is read from the disk at the desired resolution. Changes were made to the storage sequence for elevation data such that the area of operations can be of any dimensions. The USACDC supplied subroutines are described in Volume III, Sections 10.5 to 10.7 (MAPGEN, CONVERT, ROTATE).
- 1.1 <u>Tape Supplied</u> The SIAF sample case was run using a TOPOCOM tape containing elevations from the northern half of map sheet 17551. This area is part of the Hunter-Liggett Military Reservation near King City, California. The maximum resolution of the data is 12.7 meters.

- 1.2 Variable Terrain Resolution The capability is provided for varying the terrain resolution when changing from a reconnaissance mode to a combat mode and vice versa. At the start of the model the elevation data is read from the disk according to reconnaissance resolution by Subroutine RCREAD (See Volume III, Section 10.9). When a combat decision is made, the reconnaissance data is saved on a temporary file while Subroutine CMREAD obtains from the original disk file the elevation data at combat resolution (See Volume III, Section 10.8). Due to the requirement for more storage at greater resolution, the area considered during combat is smaller than the entire area of operations. The center of the combat area is determined dynamically by considering the SIAF position, target position, projected deployment point, and projected engagement point. The best shaped rectangle for containing these points is selected. In case the boundary of this area is crossed during combat the combat area is shifted. This is done by Subroutine OUTSID (See Volume III, Section 10.10). When the simulation returns to a reconnaissance mode, the old elevation data is retrieved by Subroutine CONMIS (See Volume VI. Section 3.14)
- 2.0 <u>Vegetation</u>, <u>Microrelief</u>, <u>and Soil Shapes</u> The Terrain Submodel has been reprogrammed to consider vegetation, microrelief, and surface features as polygons. These polygons are input as rectangles, circles, or triangles. Dominant classes are used to describe the area not covered by a polygon. (See Volume II, Section 2.1)
- 3.0 <u>Antipersonnel Mines</u> Capability has been added to allow a preplanned Claymore mine ambush. In the reconnaissance mode the SIAF moves to the mine deployment area and hand emplaces the mines. When a target comes within detection range, control is shifted to the Combat Submodel to consider detailed detection, movement, and lethality of the mines. (See Subroutine MINES in Volume VI, Section 3.18).
- 4.0 <u>Dynamic Action/Reaction</u> Provisions have been made to allow dynamic actions and reactions of the two opposing forces in combat. The action is taken following detection of the adversary. When the target detects the attacker, it can either

- withdraw
- deploy in place
- open fire
- ignore the detection
- rotate the formation
- move to best deployment position

The desired option is a user input. If the attacker detects a change in the original status of the target, it can withdraw, change its deployment point, or exchange roles between the maneuver unit and the base of fire. The target then gets to react one more time to a subsequent detection of a change in the attacker's intent. This capability is described in Subroutines REACT and CREACT (See Volume VI, Sections 3.16 and 3.17).

- 5.0 <u>Internal Communications</u> An internal communications submodel has been added to the SIAF Combat Model to introduce delay times for communications between maneuver units. Three messages were incorporated for use requiring internal communications. These are "break contact" "change deployment point", and "exchange roles between the base of fire and the moving maneuver unit". For each message an heirarchy of preferred communications means is input. These are selected from visual hand signals, aural communication, radio, smoke grenades, and sending a messenger. Additional messages could be easily added to this list. Internal communications are controlled by Subroutine IC (See Volume III, Section 8.2).
- 6.0 <u>Hand Grenades</u> Hand grenades have been added as an alternative weapon for a firefight. Logic was developed such that hand grenades are used at short ranges when the firer is highly suppressed. Existing routines in the Fire Control and Lethality Submodel were expanded to cover the employment decision and the simulation of the lethality of hand grenades. (See Volume VI, Section 2)
- 7.0 External Fire Support An extensive effort was undertaken to provide a stochastic, dynamic model of external fire support during combat. Subroutines EFSTIM (See Volume III, Section 5.3) computes the times of arrival of either artillery shells or bombs. This is based on the tactical situation and the input delay times associated with requesting fire

support. Subroutine EFS1 (See Volume III, Section 5.2) stochastically computes the effects of each burst. This is based on input range and deflection errors, ballistic dispersion errors, and lethality data. Provisions are included to adjust firing between volleys when an observer is present.

8.0 Model Demonstration and Validation - This requirement calls for the performance of test runs on the USACDC 6500 computer at Fort Leavenworth, Kansas. These test runs are to be selected from historical examples, field tests, or other appropriate sources. They are to be used to verify the predictive capabilities of the integrated reconnaissance and combat SIAF model. Considerable effort was undertaken to discover appropriate data soruces to use for a test case. The SIAF model requires very specific inputs in terms of a detailed operations plan, a tape containing the elevation and vegetation data for the area of operations, the weather, and detailed information on the locations of the targets. In the Combat Model, the SIAF makes decisions based on input decision criteria. Although extensive data was collected by The Vertex Group of the Research Management Corporation on historical SIAF operations, the data requirements for a simulation were not met. In the area of field tests, it was found that the only appropriate field test was the reconnaissance test performed at Hunter-Liggett in 1971. This was previously simulated and the results are presented in Volume I, Section 6. It does not include any of the combat model.

The approach taken by TRW to satisfy this task was in two parts. The first is a detailed validation through an experimental field test of the line-of-sight prediction portion of the model. This was felt important because it is a key driver of the events in the model. For this purpose an experiment was performed at the Hunter-Liggett Military Reservation where line of sight distances were measured from known locations at various headings. This test was simulated using the appropriate portions of the SIAF model with the elevation data tape from the Defense Mapping Agency. Resolution was varied from 12.7, 25.4 and 50.8 meters between elevation points. Results were found to be very close for rolling terrain at the 12.7 meter resolution, with a fast decline in accuracy as resolu-

tion was lowered. The simulation was also performed using the ASARS technique of modelling relief. It was found that the SIAF technique was slightly more accurate at 12.7 meter resolution and that the ASARS technique did not give credible results at lesser resolutions. This test is described in Volume I. Section 8.

The second step in model verification is to present a detailed examination of a sample case. This case is to be demonstrated at the SIAF Executive Overview Meeting on 18 January 1974 at Fort Benning, Georgia. The presentation will show the decisions, events, actions, and results of the SIAF simulation for a typical scenario. A qualitative assessment is to be made by experienced SIAF personnel. The sample case is also presented in Volume I, Section 6.

- 9.0 <u>Documentation</u> The documentation for the current contract is provided as augmentation to the documentation from previous contracts. The most recent version was published in December 1972. All routines that were added or modified are to be replaced or added as specified in the augmentation instructions. The result is an integrated whole.
- 10.0 <u>Train Government Personnel</u> A training class is scheduled for the week of 14 January 1974 at Fort Benning, Georgia. This class will teach analysts and programmers to understand, use, and modify the SIAF model. The class sessions are to be videotaped and placed in the videotape library at the U.S. Army Infantry School.
- 11.0 <u>Stop/Restart</u> Capability has been added to the model to allow several stop points. At the point in the model that the stop point is reached, all of the common blocks are copied onto a disk. The model can then be restarted from that point for later use. This allows playing the combat portion separately and running it many times without repeating the earlier portions of the mission. This is performed by Subroutine RESTRT (See Volume III, Section 10.4).
- 12.0 <u>Integrated, Debugged Model</u> The additions to the SIAF Model have been fully integrated with the previous version. The model has been debugged and is operational. At the time of this writing, it is scheduled to be installed on the CDC 6500 computer at Fort Leavenworth, Kansas

within a few days. Since the previous version is currently installed, no difficulties are foreseen.

13.0 <u>Model and Documentation Requirements</u> - Standards for the model and the documentation have been fully followed from USACDC supplement 1 to AR-18-7 Appendix M.

This document, prepared under ARPA Contract DAAHO1-73-C-0914, contains changes and additions to Volume I, of the SIAF System Model User's Manual, 15 December 1972; hence, these pages replace or augment appropriate pages of the above referenced document. Table I provides instructions for accomplishing these changes to Volume I. (The pages in this document appear in the order in which they are referenced in Table I. As shown in Table I, for example, Pages i through ix of this document replace Pages i through xiii of Volume I of the User's Manual dated 15 December 1972.

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1.0 INTRODUCTION

The Small Independent Action Forces (SIAF) System Model User's Manual consists of six volumes. Volume I provides the information necessary to actually operate the model on the computer while Volumes II, III, V and VI provide the more detailed analysis and discussion of the subroutines.

Volumes II and III contain the reconnaissance routines developed under ARPA Contract DAAHO1-71-C-0100 while Volumes V and VI are the combat routines developed under Contract DAAHO1-72-C-0305. All of the volumes have been modified under Contract DAAHO1-73-C-0914.

These volumes are as follows:

Volume I - Model Description and Programming Guide

Volume II - Reconnaissance Subroutines (Terrain, Weather, Targets)

Volume III - Reconnaissance Subroutines (SIAF Functions and Ancillary Routines)

Volume IV - Model Program Listing

Volume V - Combat Initialization Subroutines

Volume VI - Combat Execution Subroutines

The first volume contains general information concerning the use of the model. The first section contains a qualitative description of the model and associated subroutines. This is followed by sections which present alphabetical lists of the model input and output variables. Next, the model subroutines are presented and summarized (details of each subroutine are contained in Volumes II, III, V and VI). Finally, a sample case consisting in part of the simulation of a test conducted at Hunter Liggett Military Reservation and computer operating procedures are included.

2.0 PROGRAM DESCRIPTION

The SIAF system model is a computer simulation intended for use in evaluating the effectiveness of alternative SIAF concepts. This model essentially accepts as input a military operations plan, such as would be prepared by the military commander for an actual patrol operation, and simulates this operation in a computer environment. It considers a small independent action force which follows this operations plan, and considers both reconnaissance and combat missions. The SIAF model simulates the interaction of the operations plan with the terrain, weather, and enemy situation and considers a total mission from beginning to end. The output of the model is the effectiveness of the particular operation under consideration. During the simulation of the activities and events which occur during SIAF operations, the model calculates statistics pertaining to movement, navigation, surveillance and detection, fire support, supply maintenance, human maintenance, and communications. The specific objectives of this modeling effort were as follows:

- Develop a methodology for modeling a SIAF patrol and implement the methodology.
- 2) Quantitatively measure the reconnaissance and combat effectiveness of alternative SIAF concepts.
- 3) Identify those variables which have the greatest impact on the overall effectiveness of SIAF.

2.1 SIAF MEASURES OF EFFECTIVENESS

In order to satisfy the objectives stated above, one of the first tasks that had to be performed was that of defining appropriate measures of effectiveness for SIAF since these are essentially the outputs of the model. For this purpose, experienced patrol leaders representing various military organizations were interviewed. Based upon these discussions, a list of measures of effectiveness was identified. Some of these measures are shown in Figure 2.1.

As an example of how these measures are applied to a SIAF problem, consider a situation where the user desires to compare the relative merits of two sensor systems, one of which is bulkier and requires a larger crew but is very reliable, versus less reliable equipment which is lighter and

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- INSERTION SUCCESSES/ATTEMPTS
- PATROL DURATION
- DISTANCE TRAVELED

NAVIGATION MOE'S

- NAVIGATION ACCURACY
- TARGET LOCATION ERROR

SURVEILLANCE MOE'S

- NUMBER OF TARGETS DETECTED
- NUMBER OF TARGETS IDENTIFIED
- NUMBER OF TIMES STAF IS DETECTED

FIRE SUPPORT MOE'S

- NUMBER OF SIAF CASUALTIES
- NUMBER OF ENEMY CASUALTIES
- NUMBER OF TIMES ENEMY IS HIT BY FIRE

SUPPLY MAINTENANCE

- PATROL WEIGHT
- PERCENT SUPPLIES CONSUMED
- PERCENT AMMUNITION EXPENDED

HUMAN MAINTENANCE

• HUMAN PERFORMANCE DEGRADATION

COMMUNICATION MOE'S

 COMMUNICATION SUCCESSES/COMMUNICATION ATTEMPTS

Figure 2.1, Typical SIAF Measures of Effectiveness

requires a smaller crew. For this purpose, measures such as detection per detection opportunity and man days per detection might be selected as being fundamental. Given such data, trade-offs are readily obtained providing useful guidance for research and development decision making. For examining and answering questions pertaining to engagement, the classical measures: casualties, exchange ratio (enemy casualties/SIAF casualties), and survivor ratio (SIAF survivors/enemy survivors) are computed. These measures are often used in the evaluation of competing patrol weapons mixes. Another possibility is that one might not be interested in casualties, per se, but in the number of times SIAF is able to direct fire on the enemy. This measure is also calculated by the model.

Ancillary statistics are intended to be of value for elucidation of cause and effect relationships. As a simple example in the use of these statistics, suppose that it is consistently found that battery life is a principal cause of communication failures. Given typical patrol durations and communication frequencies, a clear justification is available for a development effort aimed at extending power source endurance.

In summary, because of the requirement for the model to apply to general SIAF problems, a large number of measures and ancillary statistics are calculated and provided by the model. Application of the model requires that the user select from these data those statistics which pertain to the particular problem of interest. (Details of the model outputs are provided in Section 4.0 of this volume.)

2.2 MODEL APPROACH AND REQUIREMENTS

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The approaches considered for the SIAF model included an analytical model, war gaming, and computer simulation. During this evaluation, a purely analytic model was discarded since it does not have the generality necessary to meet project requirements. War gaming is too slow and unwieldy for most SIAF purposes and is usually valuable only if copious resources and time are available. Field exercises and combat testing were also considered but were ruled out since, at times, conceptual systems must be studied by the decision maker. Simulation using analytical submodels was judged to combine the necessary generality and flexibility with acceptable speed and economy. The

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computer simulation method allows for comparing alternative concepts (i. e., different mixes of personnel, material, and procedures) within a scenario of fixed conditions and assumptions. For the SIAF project, it constituted a clear first choice.

Once simulation was selected for developing the SIAF mathematical model, the next task was to prepare specifications for developing this model. The purpose of these specifications was to identify required model inputs, outputs, and submodels. To this end, it was recognized that the measures of effectiveness illustrated in Figure 2.1 depend upon five basic factors which are the terrain, weather, enemy situation, friendly situation in terms of units which support SIAF operations, and the specific SIAF operations plan being considered. Since the basic purpose of the model is to estimate the effectiveness of SIAF operations as a function of changes in these factors, they were essentially identified as inputs to the model. This is illustrated in Figure 2.2.

In identifying the submodel areas, a vigorous effort was made to develop a model which is as realistic as possible. To this end, it was recognized that in the real world a patrol leader prepares an operations plan before he starts the mission. In this operations plan, he considers the functions of movement, navigation, surveillance and detection, fire support, supply maintenance, human maintenance, communications, and command and control. In addition, these are the essential functions the patrol performs during the execution of the plan. Hence, these areas, in addition to terrain, weather, and enemy, were identified as the major areas for submodel development. (See Figure 2.3.)

Although submodels in each of these areas could conceivably be independently developed, a realistic simulation of patrol operation must also consider the interactions of the functions shown in Figure 2.3 with each other and the weather, terrain, and enemy situation. For example, the movement rate a patrol selects will be a function of the terrain and weather, pack weight, and fatigue of the patrol members. This will have an impact on the patrol duration, distance traveled, the visual detection capability of the patrol, and the possibility that the patrol is detected. That is, if the patrol moves rapidly over rough terrain, the patrol surveillance capability is decreased since more attention must be devoted to

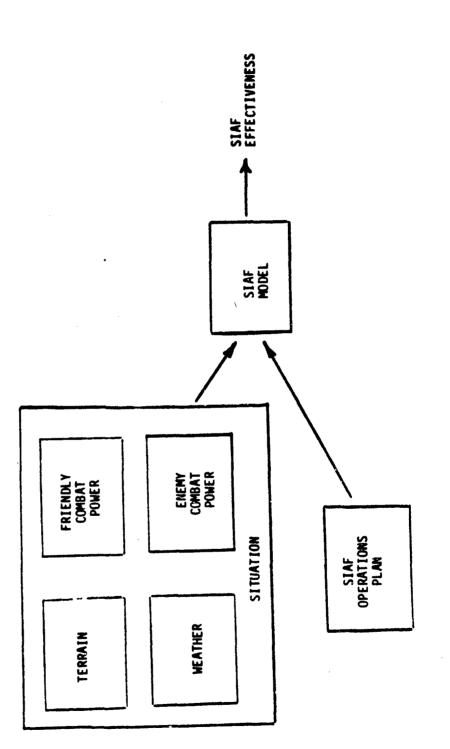


Figure 2.2, SIAF Model Overview

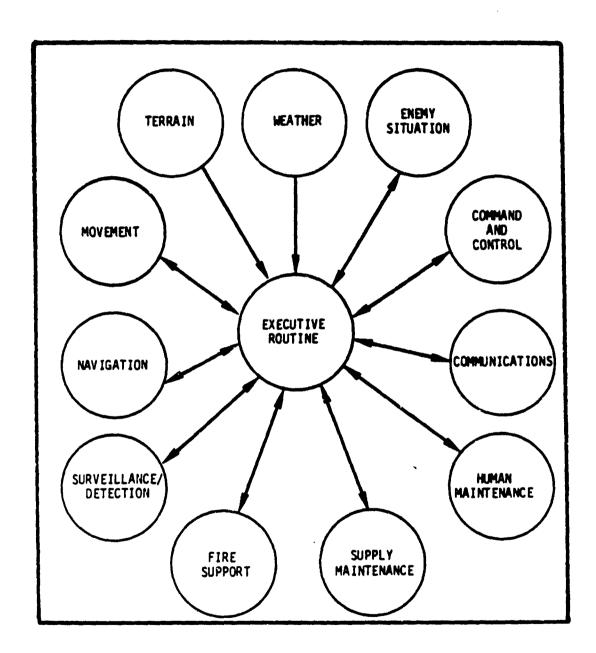


Figure 2.3, SIAF Model Elements

movement and, consequently, less can be devoted to surveillance. In addition, movement is a cue for visual detection and, hence, increases the possibility of detection by the enemy. This patrol movement rate also influences the energy expenditure rate of the patrol and the food and water requirements which are functions of the temperature and humidity and which, in turn, influence subsequent patrol movement rates. These are examples of the complex interactions which are considered in this model. These interactions are extremely important since equipments and tactics which lead to improvements in some areas could possibly result in a decrease in effectiveness in other areas (see Figure 2.1).

2.3 THE EXECUTIVE ROUTINE

The performance of many of the functions identified previously depend upon physical environment parameters of terrain and weather; as such, these subroutines use this information as input data. The problem here is that the physical environment parameters change with the location of the patrol on a route such as that shown in Figure 2.4; however, the subroutines are constrained to accept only a single value for a particular variable. A simple solution to the problem is to time step the patrol through the route using small time intervals. The idea, of course, is that if the time intervals are sufficiently small, one can assume that the appropriate physical environment parameters are constant during this interval. This approach, however, was not selected since it was felt that this would result in excessive model running time. A time step of 30 seconds, for example, would result in 28,800 time intervals for a patrol with a 10-day mission. Also, visual detection probability changes drastically as a function of light level; hence, it is desirable to examine events on a shorter time interval basis during periods of sunrise and sunset.

The possibility of using a purely distance driven simulation was also considered. However, this approach is complicated by the fact that the patrol may conduct stationary reconnaissance operations for long periods of time and normally reports its position and status to the base on a periodic basis (a function of time). Also, some targets are of such a nature that they may enter and leave the simulation as a function of time,

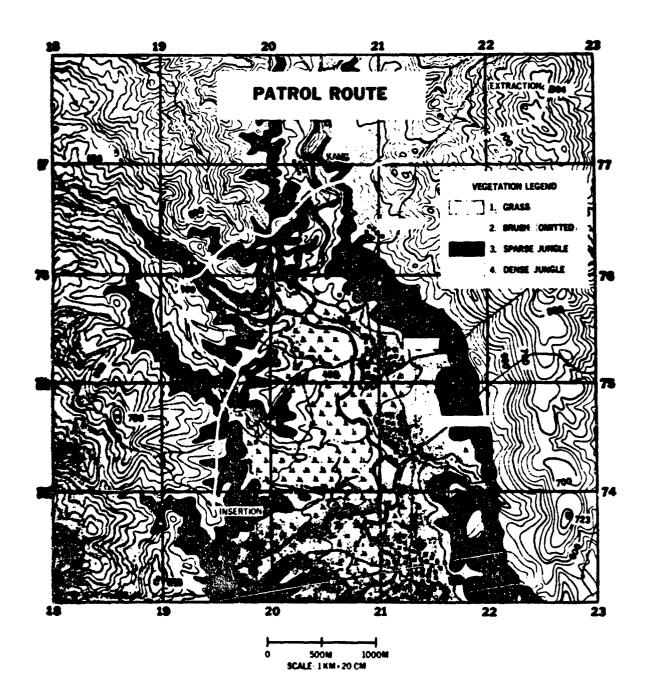


Figure 2.4, Patrol Route

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further complicating the manner in which the model is driven. Likewise, a purely event driven simulation was discarded since events such as movement and surveillance and detection are continuously occurring in patrol operations.

The resulting executive routine essentially consists of a marriage of these ideas. The basis of the concept is a grid square approach for inputting digitized terrain data and is illustrated in Figure 2.5. With this approach, a map of the area of operations is divided into grid squares whose resolution is user input. The total area is assigned a vegetation class with exceptions to this as subareas (polygons), in the form of rectangles, Circles, and triangles (user input) assigned to the total (see Volume II for discussion of the terrain model). Based upon the axis of advance of the patrol, a segment, defined as the distance of the first grid crossing, checkpoint, obstacle, or polygon crossing, whichever is smaller, is first generated as shown in Figure 2.5(b). The movement rate over this segment is next calculated and a segment time is computed. This segment time is then checked to see if any target movement or communication events are to occur within the segment. If so, the segment is redefined as the distance the patrol moves to the time that particular event is scheduled to occur. Once a segment is defined, statistics pertaining to the functions shown in Figure 2.3 are calculated and accumulated for the segment. After these calculations, another segment is generated and the process is continued until the last checkpoint is reached.

If the SIAF patrol is stationary, a time driver subroutine drives the model and uses criteria of light level and target movement for determining the time step. During periods where the light level is relatively constant and targets are beyond feasible detection ranges, the time interval selected is large. When light level changes rapidly the time step is automatically reduced to account for the change in visual detection capability which occurs in this situation. Again, statistics pertaining to the functions shown in Figure 2.3 are accumulated for each time segment.

In addition to the distance and time segments defined previously, a subset of these called mini-segments are also generated when detections are feasible. Figure 2.6 illustrates this concept which operates as follows: During a simulation of the mission, many of the targets in the area of operations are not feasible of being detected because of the distance between them and the SIAF patrol. For each segment, feasibility of

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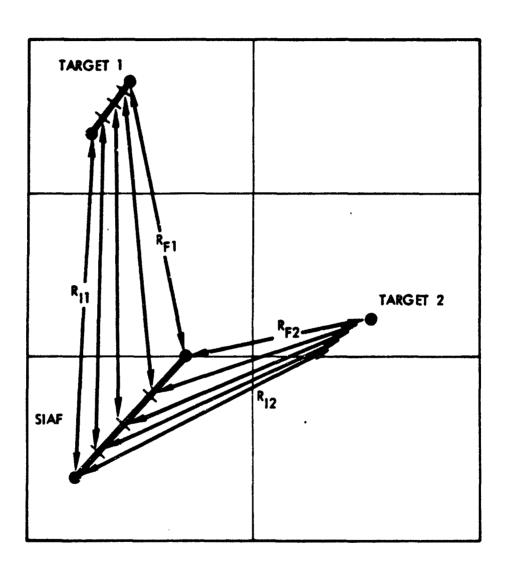


Figure 2.6, Illustration of Mini-Segments

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target detection is checked at the minimum range point and, if not feasible, the target is not considered during the next series of calculations. If feasible, on the other hand, the line of sight between SIAF and the target could change as a function of their relative positions in the segments. In this situation, both SIAF and target segments are divided into minisegments. The length of the mini-segments are user input. In this situation, the program advances SIAF and each feasible target, a mini-segment at a time, and determines a detection verdict for each mini-segment. For this calculation two options are available: In the first of these, the centroid of the patrol and each target are examined to determine if line of sight exists. If so, then it is assumed that line of sight exists between all members of each group. The user also has the option of treating man-to-man intervisibility in which he can consider the relative location of each individual in both the patrol and target formations (see the Surveillance/Detection Submodel, Volume III, Section 4.0, for the details). This option accounts for the fact that some of the individuals in a particular group may not be visible by all members of the other group. Thus, the user can consider the patrol as one point or consider individuals as desired. These options essentially serve to automatically increase the resolution of the model when required and use less detail resolution when this is appropriate. All of these features serve to minimize the running time of the model and provide the user the option of selecting the resolution he desires.

2.4 SIAF SUBMODELS AND SUBROUTINES

In this section, each of the submodels shown in Figure 2.3 is summarized and the interactions among them are described. The subroutines described herein are listed in Section 5.0 of this volume for ease in referencing. Volumes II, III, V and VI contain detailed information concerning these submodels and subroutines.

2.4.1 SIAF Terrain Submodel

The purpose of the SIAF Terrain Submodel is to provide a representation of the terrain for use in line-of-sight and slope calculations,

and for considering factors such as the vegetation at various points in the area of operations as required by the other subroutines. This submodel considers the following factors:

- Relief
- Vegetation
- Obstacles and Cultural Features
- Micro-Relief
- Surface Materials

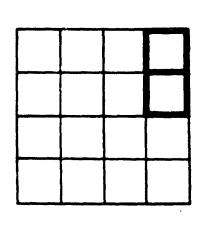
The manner in which these factors are treated in this submodel is summarized below.

Relief

The basic approach for treating relief is to divide the map into grids, whose size is a user input. The grid elevation data is obtained from a military "TOPOCOM" tape of the area of operations. The tape contains digitized elevation data of various areas and is of a high resolution. Thus, the elevation data represents the elevation at each corner of the grid square. Based upon these data, the model generates a hyperbolic surface between the points for each grid square. Figure 2.7 illustrates this surface for two grid squares. In order to explain and illustrate the results which are obtained with this approach, an ionic model of four grid squares was developed. Figure 2.8 is a photograph of this model. It illustrates the curved surface which is obtained from the four-corner input data.

As an example of the impact of various resolutions on the accuracy of the relief representation, a study was made using Army map sheet 1755 IV NE, Alder Peak California, 1:25,000. Figure 2.9 shows actual contours and the contours which result from this model using 100-meter resolution. These 100-meter data were obtained from a listing of an Army digitized terrain tape of the area. The Figure illustrates how much of the section of road can be observed from the observation post for both sets of contours; there is considerable error in the results obtained from the model when the 100-meter resolution is used. Figure 2.10 shows the same situation for 50-meter resolution. These illustrations show that accuracy

TERRAIN DATA INPUT SCHEME



VEGETATION CLASSIFICATION SCHEME

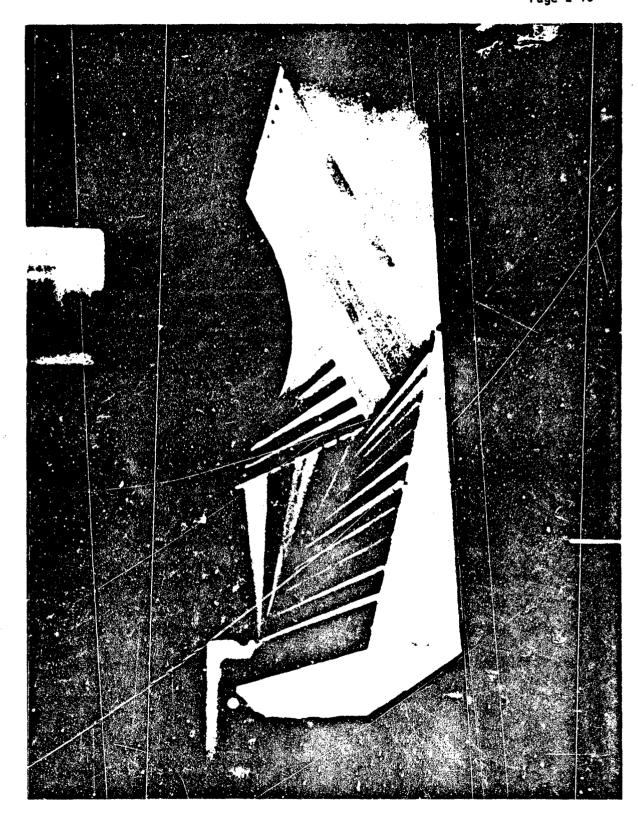
- NO VEGETATION
- SPARSE GRASS OR BRUSH
- MODERATE GRASS OR BRUSH
- DENSE GRASSLAND
- LIGHT FOREST WITH BRUSH
 - SPARSE FOREST
- MODERATE FOREST
- 8 HEAVY FOREST 9 DENSE BRUSH WITH TREES
- 10 SPARSE JUNGLE
 11 MODERATE JUNGLE
- 12 HEAVY JUNGLE

RELIEF REPRESENTATION

GENERALLY EACH VEGETATION CLASS CONTAINS

- GRASS
- BRUSH
- TREE TRUNKS
- TREE CROWNS

Figure 2.7, Terrain Model - Relief and Vegetation Summary



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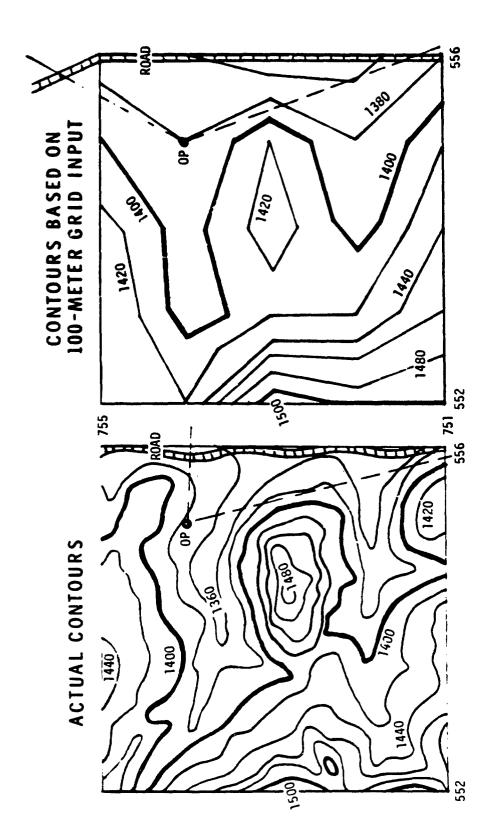
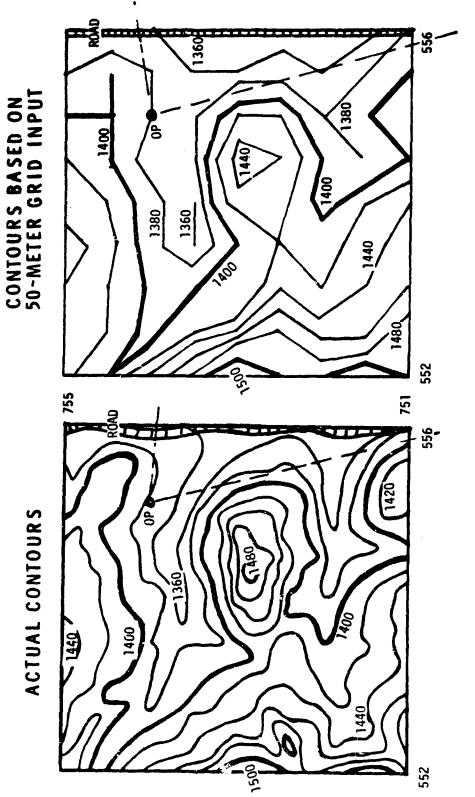


Figure 2.9, Comparison of 100-Meter Resolution Digitized Data with Map Contours



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Figure 2.10, Comparison of 50-Meter Resolution Manual Data with Map Contours

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of relief representation is considerably better with 50-meter resolution. It is interesting to note that the terrain for which this comparison was made is fairly rugged. Hence, the preceding analysis probably represents a worst-case situation.

Further comparison of the relief part of this model to field experiments is presented in Section 8.0 of this model.

<u>Vegetation</u>

The problem of appropriately modeling the vegetation factor of terrain for SIAF was approached in two steps. First, it was necessary to develop an appropriate vegetation classification scheme. Second, it was necessary to determine the manner in which this scheme could best be used, in conjunction with the relief portion of the Terrain Submodel.

The vegetation classes considered in this submodel are summarized in Figure 2.7. As shown in the figure, each class of vegetation consists of a certain amount of grass, brush, and trees. The features within each class are assumed to be distributed at random. To the total area for which elevation is input is assigned one number from 1 to 12 to represent the class (dominant) of vegetation to be found within the area. Exceptions to this are inputted as subareas in the form of triangles, circles, and rectangles and are also assigned a number from 1 to 12 and are used to represent subareas of vegetation other than the dominant within the total area.

In developing this classification scheme, an attempt was made to include consideration of the types of vegetation which might be found in various parts of the world. In addition, an attempt was also made to gather realistic data concerning the density and size of the vegetation features within each class. To this end, various references (indicated in Volume II) were studied. The data in these references were augmented by a field trip to Hunter Liggett Military Reservation where aerial photographs of the area were obtained and a ground survey was conducted.





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Figure 2.11 presents one of these aerial photographs while Figure 2.12 provides a closeup view of the vegetation in the square of Figure 2.11. Figure 2.13 is a view of the vegetation in the area of the circle of Figure 2.11. The vegetation shown in the photograph of Figure 2.12 was subsequently defined as class 5, light forest with brush. Results of the ground survey indicated that there were approximately 63 features of brush per 50- by 50-meter square, each feature being approximately 2 meters wide and 3 meters high. In addition, the 42 trees in this area were judged to be an average of 10 meters high with 3-meter wide crowns. The vegetation shown in Figure 2.13 was found to be considerably different as might be expected from an inspection of Figure 2.11. This area was defined as class 3, moderate grass or brush, and was found to consist of 500 features of brush per 50-meter square. Each feature was judged to be a sphere with a diameter of approximately 1.5 meters.

As an example of the impact of the polygon (triangles, rectangles, and circles) overlay method of vegetation representation, Figure 2.14 shows the accuracy of realism that can be obtained through this method. As can be observed, considerable accuracy can be obtained.

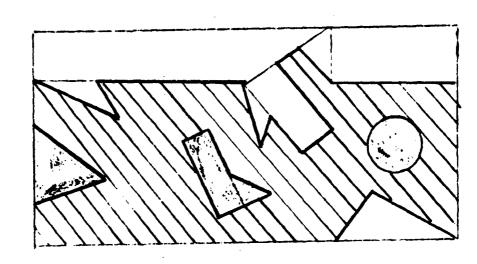
Obstacles and Cultural Features

For the purposes of modeling, cultural features and obstacles are treated in the same manner as vegetation in that a polygon configuration resembling the feature or obstacle is overlaid on the area and is assigned a number which indicates the type of area obstacle. Cultural features such as roads, on the other hand, are input by means of straight line segments. Figure 2.15 summarizes obstacles and cultural features considered in this submodel and presents an example which illustrates the input procedure described above.

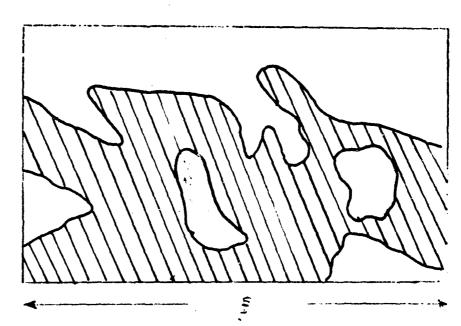
Surface Materials

The surface materials or soil classifications considered in this submodel are summarized in Figure 2.15. In preparing the inputs to the submodel, a dominant soil classification is assigned to the area of operations. Thus, if the area is considered to consist mainly of sand, then the number 2 would be associated with the area. Exceptions to this are input by a means of subareas in the form of circles, rectangles, and triangles illustrated in Figure 2.15. Thus, for example the shown, the crosshatched area would consist of high plasticity silt (class 3) while the reaminder of the area would have the dominant soil class (class 2).

Figure 2.14. Effect of Polygon Overlay on Vegetation Representation



Polygon Overlay



Representative Area

AREA

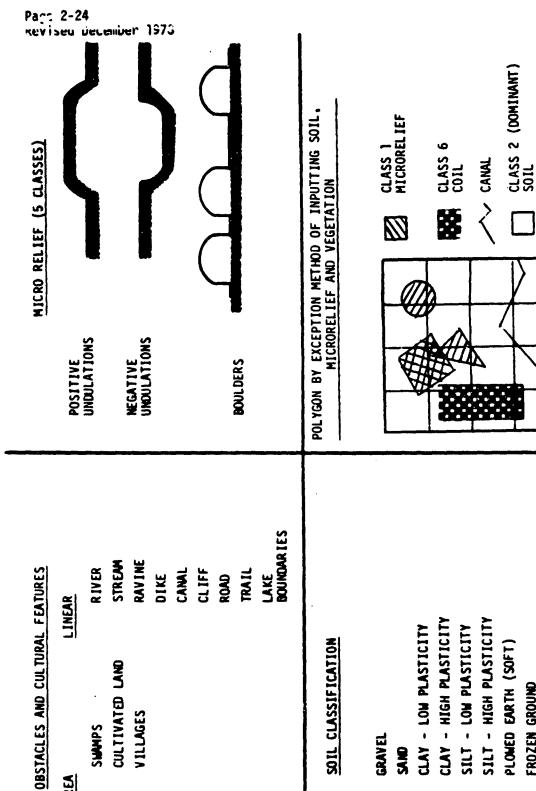


Figure 2.15. Terrain Model - Additional Factors Considered

FROZEN GROUND

CLASS 13 VEGETATION

Micro-Relief

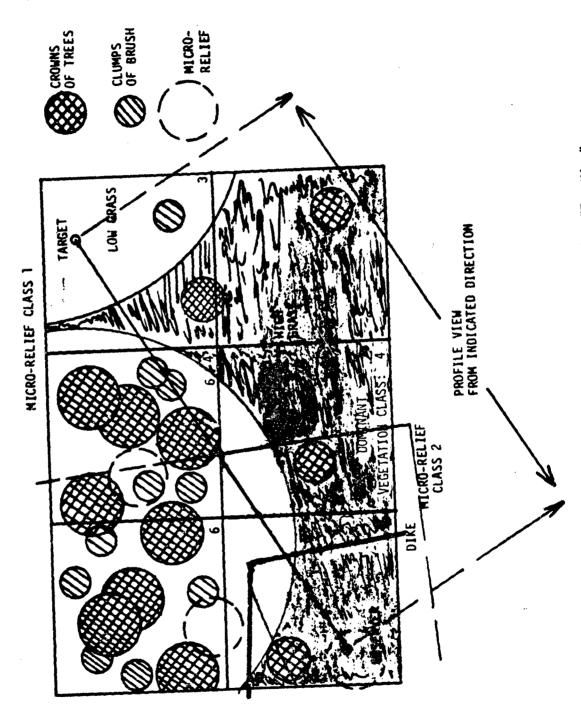
In addition to the factors considered in the foregoing discussion, certain terrain irregularities must now be considered. Figure 2.16 photographically illustrates some of these irregularities that exist at the Hunter Liggett Military Reservation. These irregularities are called microrelief for this model. Here, positive undulations, negative undulations, and boulders are considered. Each class of micro-relief consists of a combination of these features of varying densities and sizes. These features are assumed to be distributed randomly within an area; they are input by means of circles, rectangles and triangles as illustrated in Figure 2.15. Thus, the cross-hatched region, as shown in Figure 2.15, would consist of that class of micro-relief desired by the user while the remainder of the area of operations would consist of a dominant micro-relief class.

Summary

To illustrate how these factors of terrain are combined in the model, Figure 2.17, which presents a top view of six grid squares, was developed. A profile view of this situation is shown in Figure 2.18. A study of Figure 2.17 and 2.18 indicates that line of sight could be obstructed for a variety of reasons. For example, line of sight could be obstructed by relief, an obstacle, features of brush, crowns of trees, or trunks of trees. The relief and obstacle line-of-sight decision is essentially a deterministic one which is based upon the geometry of the situation while the line-of-sight verdict due to vegetation and micro-relief is a probabilistic one. Furthermore, this probabilistic verdict depends upon the relative location of the vegetation features and the micro-relief features with respect to the observer and the target. For example, features close to the observer tend to have a greater impact on concealment probability than do those further away. See Sections 2.5, 2.10, and 2.11 in Volume II for concealment analysis and description of equations.

This total line-of-sight decision calculation is made by Subroutine TERCON which in turn calls eight other terrain subroutines as illustrated in Figure 2.19. Here, Subroutines MICSOL and MITFEA essentially determine if a target is on a micro-relief feature or on an obstacle such as a swamp. Both of these factors are used to adjust the height of the target





-- 7 17 second 1 thanks in the Situation "Top View"

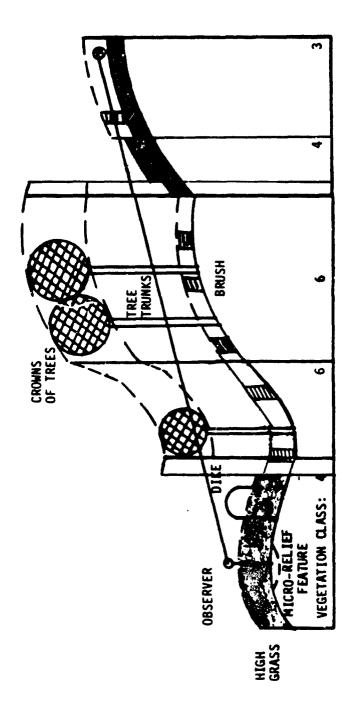


Figure 2.18, General Line-of-Sight Situation "Profile View"

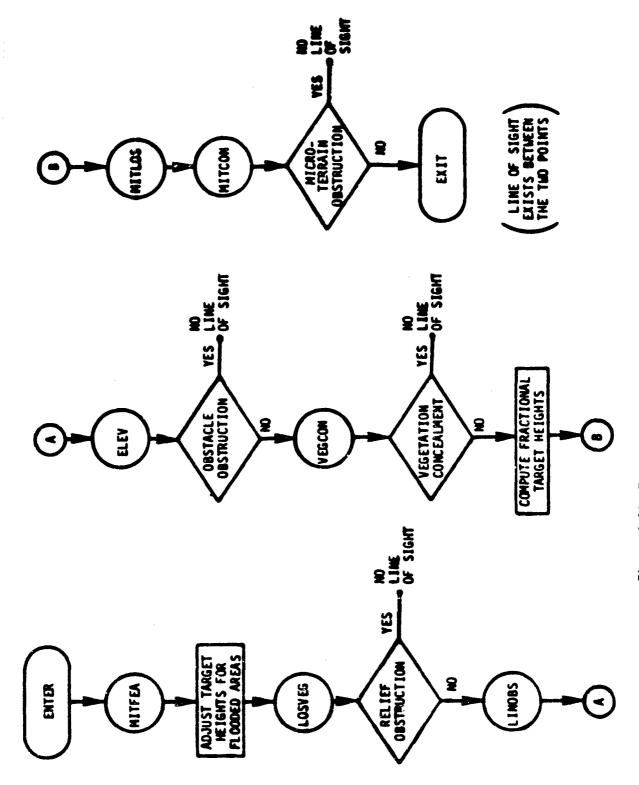


Figure 2.19, Terrain Concealment Subroutine (TERCON)

appropriately. Next, Subroutine LOSVEG is called and determines if there is a relief intercept between the two points of interest. If so, a noline-of-sight verdict is returned by the subroutine. If there is not a relief obstruction, Subroutines LINOBS and ELEV are next called. These subroutines essentially determine if there is an obstacle between the two points of interest and determine the elevation of the obstacle. Based upon these calculations, a check is made for an obstacle obstruction and a line-of-sight/no-line-of-sight verdict is again made as shown in Figure 2.19. If line of sight exists, then Subroutine VEGCON is called to check the vegetation concealment. As part of this calculation it could turn out that a target is partially concealed because of vegetation. If so, the area of the target visible is calculated. The final two subroutines, called MITLOS and MITCON, determine if there is a micro-relief obstruction between the two points of interest.

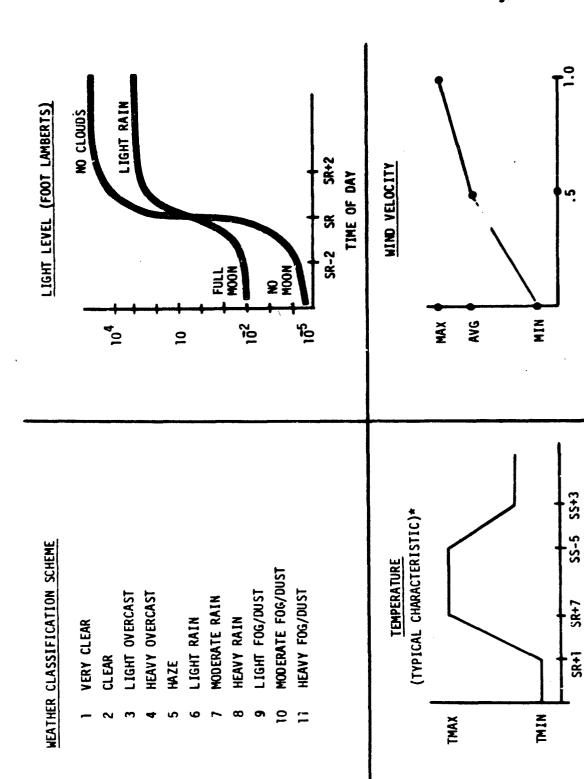
In summary, Subroutine TERCON determines if there is line of sight between any two points in the area of operations. The line-of-sight verdict is based upon an examination of relief, obstacles and cultural features, vegetation, and micro-relief which exists between the two points under consideration.

2.4.2 SIAF Weather Model

Figure 2.20 shows Weather Subroutine variables for weather classification, light level, temperature, and wind velocity. In the model, these variables are functions of time. When a subroutine needs a particular weather variable, the model simply examines the weather variables at the time in question and selects the appropriate values. The 11 classes of weather which vary from clear to heavy fog are input by the user as a function of time. Figure 2.21 is an example of the procedure to input variables for the Weather Subroutine.

The light level data of Figure 2.20 (foot lamberts versus time) were obtained from Reference 1 and, as shown, varies rapidly near sunrise (SR) and sunset (SS). (Only sunrise is illustrated in the Figure since sunset is essentially the reverse of this.) The model also considers the interaction of these basic light level data with the weather in that the light level is degraded appropriately depending upon the weather conditions which exist at the time the light level is sampled.

RANDOM NUMBER



€,

*Use local data for time scale.

HOUR OF DAY

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	RISE SET	MOON	TEMPERATURE MAX MIN	ATURE	HAMIDITY MAX MI	HAMIDITY Ax min	MIN	MIND VELOCITY (KNOTS) MIN AVG MAX	KNOTS)	MIND DIRECTION
10	1148 019	0156 lst Q.	78°F	30°F	%86	24%	0	2	7	360
02 12	49 0235	35	*	32	88	91	0	0.25	2	330
03 134	49 0307		78	32	66	18	0	0	0	0
	46 0335	35	8	7	66	45	•	puis	∞	320
05 154	1542 0400		29	32	5 6	9	0	8	80	090
90 16:	38 0423	23	89	92	66	22	0	m	12	060
71 70	1733 0446	• •	99	32	86	32	•	ις.	38	250

Figure 2.21, Example Weather Input Values

The temperature curve was derived empirically from data collected at Los Angeles Civic Center and Hunter Liggett Military Reservation. Examination of these data revealed that the temperature begins to increase approximately one hour after sunrise (SR) and reaches its maximum value about seven hours after sunrise. Then it stays relatively constant with time, starts decreasing approximately five hours before sunset (SS), and reaches its minimum value at three hours after sunset. Based upon these observations, the temperature model shown in Figure 2.20 was constructed. The maximum and minimum temperatures and the time scale for any locality for each day of the operation would be input by the user; then the model will generate a curve as shown in the Figure. Relative humidity (not shown is treated in a similar manner, but it decreases as temperature increases.

Finally, the maximum, average, and minimum wind velocity is input by the user, and a random number is drawn to determine the appropriate velocity Wind direction is input as constant. This sample procedure essentially accounts for gusts. If a constant wind scenario is desired, the user can simulate this by equating the minimum, average, and maximum velocities.

2.4.3 Enemy Situation

Three options are provided in the model for treating the enemy. These are illustrated in Figure 2.22. As shown in the Figure, the user can have fixed enemy positions, can simulate an enemy movement in a random manner within a circular area of operations, or can simulate the enemy moving on a pre-planned path. For the random movement within a circle on the fixed targets, the user can either pre-select the initial positions of these targets or can have the computer select these positions at random. Targets such as trucks, personnel, and enemy caches are simulated by inputting appropriate target characteristics. Analyses and discussion of target movement are contained in Sections 4.1 and 4.3 of Volume II.

Subroutines pertaining to the SIAF functions are described next. These subroutines are exercised for each segment as discussed in Section 2.3.

2.4.4 Movement

This subroutine calculates the movement rate of the patrol to be consistent with maintaining good surveillance and detection capability. Figure 2.23 presents a simplified flow diagram of how this movement rate,

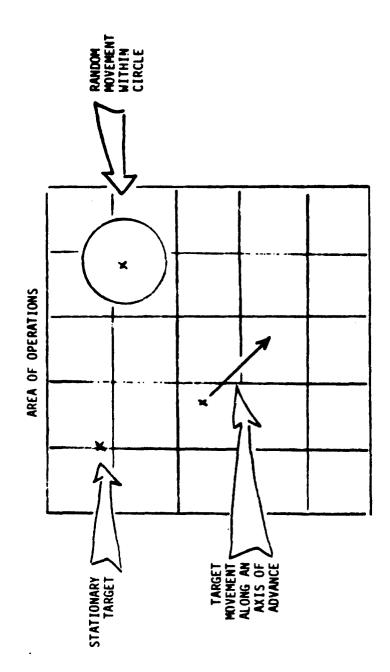
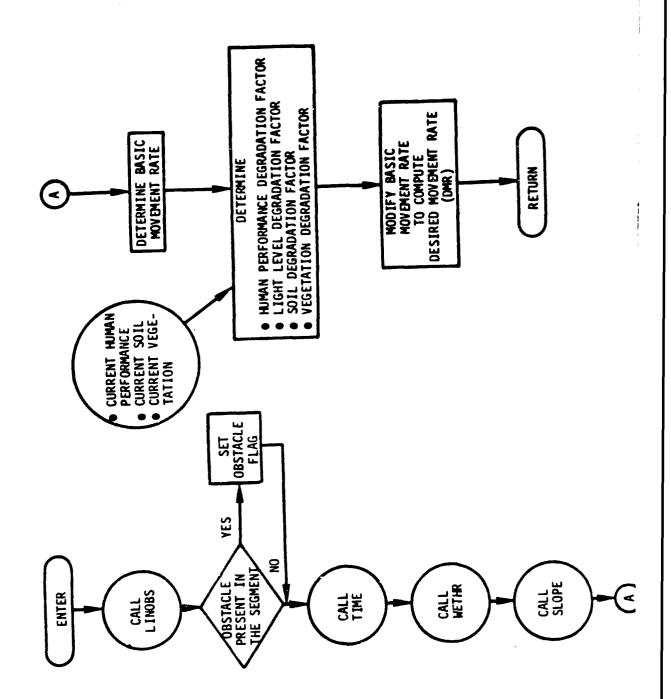


Figure 2.22, SIAF Model Threat Options

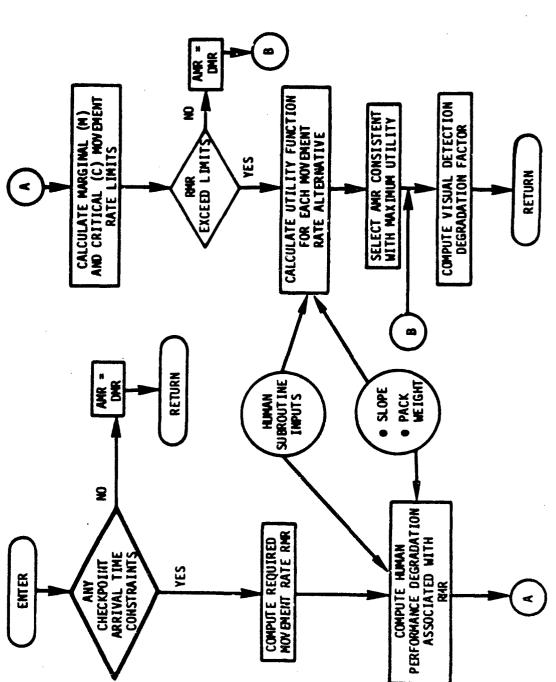


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called desired movement rate, is calculated. Upon entering this subroutine, a distance segment (see Figure 2.5), based upon the minimum of the distance to a checkpoint, terrain polygon crossing, or grid crossing, has already been calculated by a segment generator subroutine (see Volume III). The first check made in this subroutine is one to determine if the segment intersects a linear obstacle. For this purpose, Subroutine LINOBS is called and an appropriate flag is set if required. After this calculation, Subroutines Time, Weather, and Slope are called as shown in Figure 2.23, and a basic patrol movement rate is determined by means of a table look-up procedure. This movement rate is then modified to account for the current human performance level of the patrol, and the current soil and vegetation the patrol is moving through (these interactions among subroutines are illustrated by means of circles in Figure 2.23). The output of this subroutine is called the desired movement rate and is defined as that movement rate consistent with good surveillance and detection capability.

Although a desired patrol movement rate has been determined in the previous subroutine, it could turn out that time contingencies require that the patrol move faster than this rate. In order to determine an actual patrol movement rate, a movement command and control subroutine, illustrated in Figure 2.24, is used. As shown in the Figure, the checkpoints from the present patrol position to the end of the patrol route are first checked to determine if there is an arrival time constraint associated with any of them. If not, the actual movement rate is set equal to the desired movement rate. If a checkpoint has an associated arrival time, then the required movement rate, based upon the distance from the patrol to the checkpoint, and the remaining time is calculated. These calculations essentially simulate the commander's estimate of his required movement rate which he would obtain in a similar manner.

Since it is possible that this required movement rate could exceed certain human and physical, environmentally constrained limits, both critical and marginal movement rate limits are next calculated. This marginal movement rate limit is defined as the minimum of the desired movement rate and a 10 percent margin associated with a movement rate consistent with zero body heat storage. The critical movement rate is defined as the minimum of three times the desired movement rate (which is



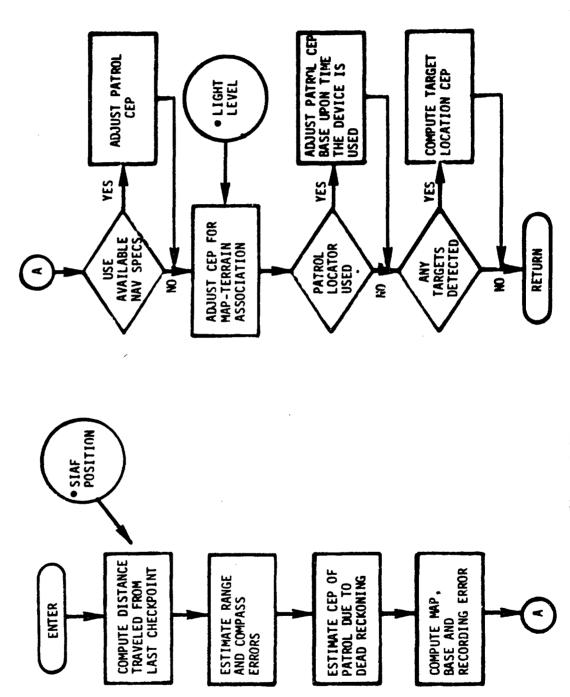
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Figure 2.24. Movement Command and Control Subsouttine (Crimu)

estimated to be the nominal movement rate due to the terrain and weather) and that movement rate at which the body just maintains thermal equilibrium. As shown in Figure 2.24, these factors are functions of the current status of the patrol which is available in the communication block of the program. If the required movement rate is less than these limits, then the actual movement rate is set equal to the desired movement rate. If the required rate exceeds these limits, then the patrol leader must trade off his surveillance capability and time. For this purpose, weighting factors for each of these performance variables are provided as input, thus allowing the user the capability to consider alternative movement rate tactics. Based upon these input weighting factors, an actual patrol movement rate is selected and the visual performance degradation factor associated with this movement rate (used by the Visual Detection Subroutine) is calculated.

2.4.5 Navigation

The purpose of this subroutine is to determine the CEP of the patrol location. During the conduct of a mission, the patrol normally determines its location at the various checkpoints and reports its position to the base. However, if a target is detected or another contingency develops, the patrol may need to know its location at positions in between checkpoints. This location error is a function of the distance the patrol has traveled since it last updated its position. Figure 2.25 summarizes the calculations made in this subroutine which starts by computing the range and azimuth errors associated with navigation from the last checkpoint. These deadreckoning errors are then combined with map, base, and recording errors, and a basic patrol CEP is calculated. Next, the user has the option of adjusting this calculated CEP in accordance with the specifications provided in Reference 2. Independent of these specifications, the patrol could improve its initial estimate of its location by map terrain association if the light level is favorable. This essentially adjusts the location estimate to account for readily identifiable terrain features which the patrol leader could use to more accurately determine his position. Finally, the user has the option of specifying certain patrol location equipment which aids the patrol in determining its position. If this equipment is specified, then the patrol location is adjusted, based upon the amount of



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Figure 2.25, Navigation Subroutine (NAV)

time this equipment is used. These steps serve to determine a CEP of the patrol location. As shown in Figure 2.25, if a target is detected, this subroutine also calculates the CEP of the location of the target with respect to the patrol. This calculation is based upon considerations similar to those previously described.

2.4.6 Surveillance/Detection

Aural Detection

The purpose of this subroutine is to determine an aural detection verdict for SIAF against the targets in the area of operations and for the targets against SIAF. The aural detection capability of an individual depends upon the local background sound level and the sound level being made by the individual. The first calculation made in this subroutine, shown in Figure 2.26, is to determine the local aural background level for SIAF and for the targets. This background level is a function of the vegetation, time of day, and weather. Next, the source noise level for SIAF and the targets is computed. This source noise level depends upon the number of men in the unit, their disposition, and their present activity. If, for example, the patrol is moving through heavy vegetation, then its source noise level is considerably higher than it would be if the patrol were conducting a stationary reconnaissance. Based upon these two calculations, the sound level arriving at the listener is computed (considering range and vegetation attenuation) and is compared with the hearing threshold and the local background noise. If the threshold is exceeded, then the appropriate detection opportunity is stored in a vector for subsequent analysis by the Detect and Decision Subroutines.

Visual Detection

The Visual Detection Subroutine is illustrated in Figure 2.27. The purpose of this subroutine is to calculate probability of making a single glimpse, visual detection of targets that are feasible of being detected by SIAF, and for targets to detect SIAF. In this calculation, line of sight between SIAF and the targets is assumed. Hence, the calculation mainly considers light level for the detection computation. As shown in Figure 2.27, the first calculation is to determine the target reflectance, background reflectance, the light level at the target, and the light level

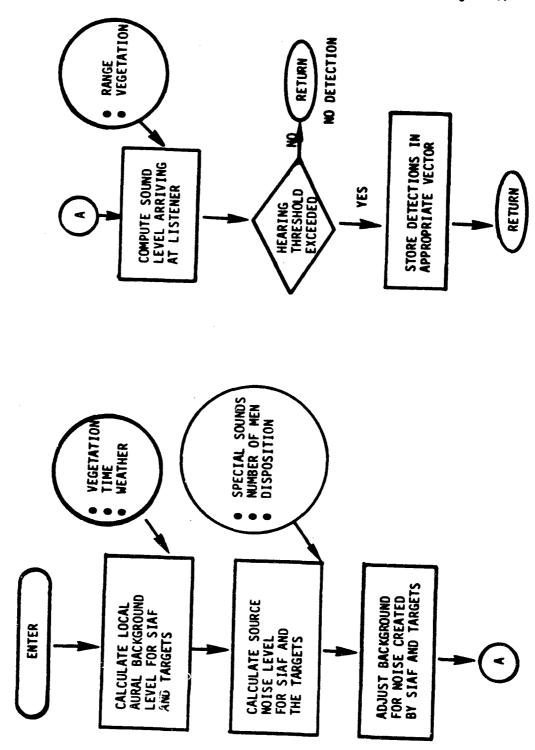
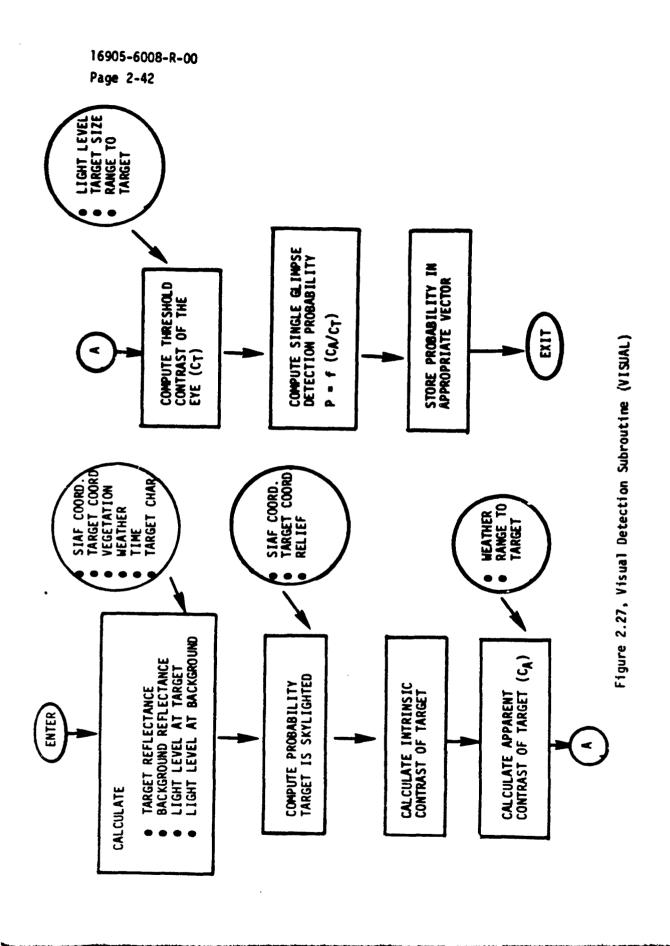


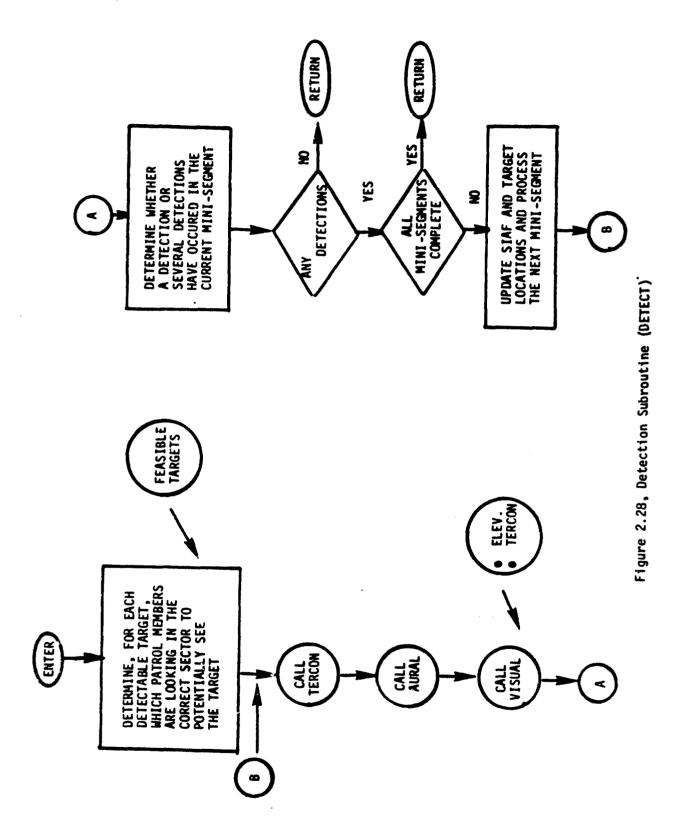
Figure 2.26, Aural Detection Subroutine (AURAL)



of the background. Depending upon the location of SIAF and the particular target under consideration, there is a possibility that the target may be skylighted. The next calculation is then made using the Terrain Concealment Subroutine to determine background conditions, including skylighting. Based upon this information, the intrinsic contrast of the target is computed. This intrinsic contrast is essentially the ratio of the brightness of the target to the brightness of the background. Depending upon the range between SIAF and the target and the weather conditions, the contrast of the target as observed by the eye differs from the intrinsic contrast. This is called apparent contrast and is next calculated considering the factors mentioned above. The third contrast calculated in this subroutine is threshold contrast of the eye. As indicated in Figure 2.27, this threshold contrast is a function of the light level, target size, and the range to the target. The ratio of apparent contrast to threshold contrast is then used to determine a single glimpse detection probability. This probability is then stored in an appropriate vector as further indicated in Figure 2.27.

Detect

The described calculations serve to determine detection opportunities and are independent of line of sight. Subroutine Detect, illustrated in Figure 2.28, combines these calculations with the relief and vegetation and considers the physical location of SIAF and the target. As mentioned previously in Section 2.3, this detection calculation is made once for each mini-segment and can consider man-to-man detection if desired by the user. The first calculation made is to determine which patrol members are looking in the correct sector to potentially see the target. If, for example, no patrol members are viewing any targets, then detection is not feasible. For all feasible targets, Subroutines TERCON, AURAL, and VISUAL are next called. These subroutines essentially examine line of sight between SIAF and the target, sound levels made by SIAF and the target, and light level to determine whether detection or several detections can possibly occur in the mini-segment. Based upon this information and the time available, detection verdicts are calculated in a Monte Carlo fashion for SIAF and all detectable targets. The order and interval between detections is created to identify who sees who first and later is used in the decision model to determine simultaneous detection/counterdetection situations.



2.4.7 Fire Support

If a patrol detects a target, it may elect to direct fire on the target, without engaging in a firefight depending upon the mission and the situation at the time of detection. For this purpose, an external fire support subroutine (EPS) is called by the Executive Routine. As shown in Figure 2.29, the user can select air, artillery, or manual qunfire for analysis. If air is selected, then the assumption is made that the target movement provides negligible error in ordnance delivery CEP. Because of the response time of artillery and naval guns, a moving target could introduce decreased accuracy in delivery CEP; hence, the user can examine this situation if desired. As shown in Figure 2.29, factors such as surprise and adjusted fire, target reaction to the first round hit, and the interactions of the effectiveness of the fire support mission with the patrol and target location errors are considered. If preliminary fire support is to be used prior to attacking a target, a detailed simulation of external fire support effectiveness is used. This is discussed in the Combat Submodel description.

2.4.8 Supply Maintenance

The Supply Maintenance Subroutine illustrated in Figure 2.30 is essentially a booking subroutine which increments and/or decrements the supply status of the patrol during each segment. As shown in the Figure, food, water, ammunition, and pack weight are incremented if the patrol was resupplied during the last segment and decremented for combat operation and for normal food and water consumption. The normal food and water consumption requirements are calculated in the Human Maintenance Subroutine which follows.

2.4.9 Human Maintenance

This subroutine computes food and water requirements for the patrol and calculates the current human performance degradation of the patrol. As illustrated in Figure 2.31, the current energy expenditure rate of the patrol members is first determined. This is based on the current patrol activity which includes rest, sleep, stationary reconnaissance activities, or movement. During movement, the energy expenditure rate is a function of the slope, pack weight, and movement rate, for which values are available to this subroutine via the communication block of the program. Once the energy expenditure rate is determined, the value of the segment time is used

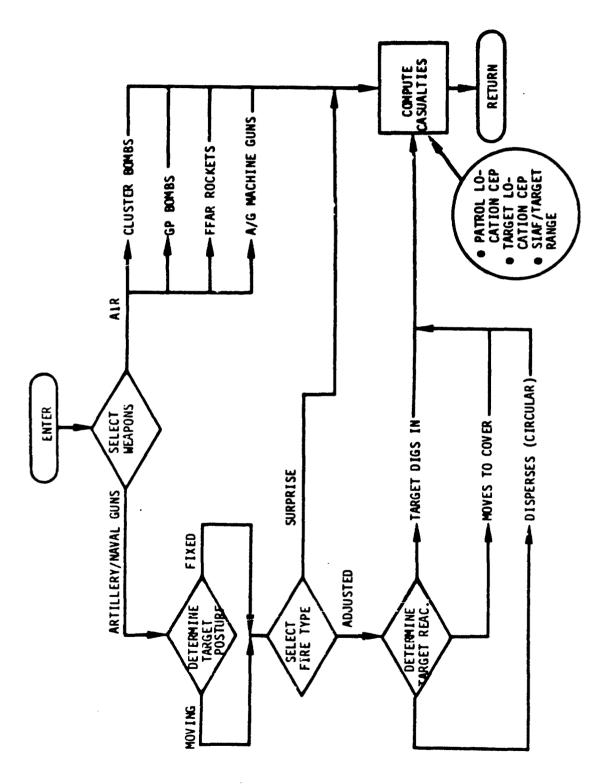


Figure 2.29, External Fire Support Subroutine (EFS)



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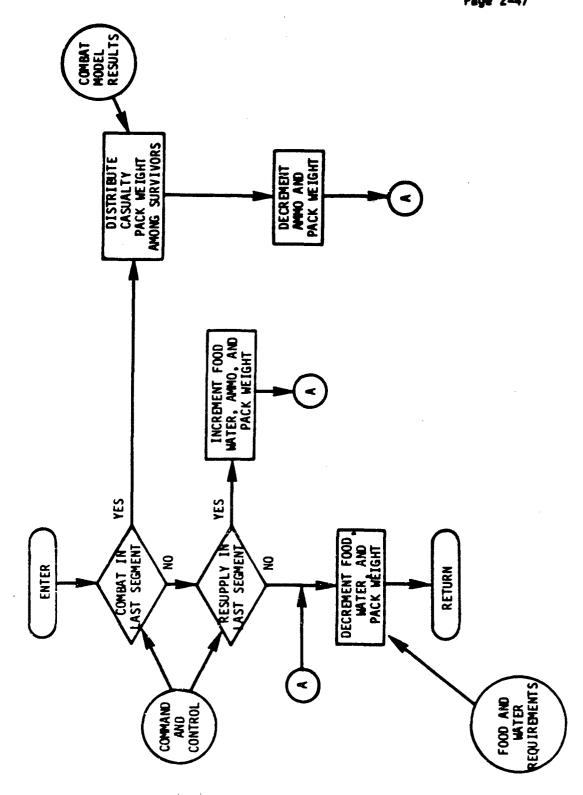


Figure 2.30. Supply Maintenance Subroutine (LOGIS)

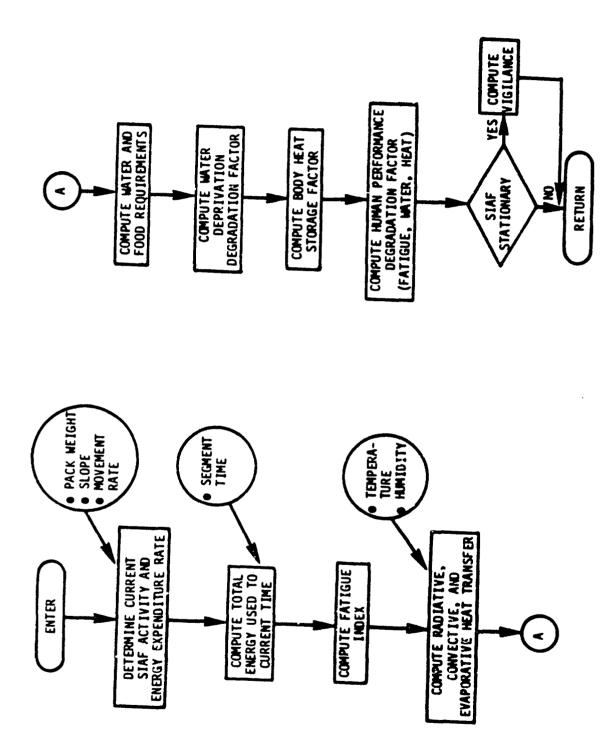


Figure 2.31, Human Maintenance Subroutine (HUMAN)

to compute energy expenditure and an associated fatigue index as shown in Figure 2.31. This energy expenditure is then used to compute the body heat lost through radiation, convection and evaporation. From this, food and water requirements and body heat storage are calculated. These factors are then combined and a human performance degradation factor is computed. This human performance degradation factor is the amount in percent by which the performance of patrol functions such as visual detection are degraded due to fatigue, body heat storage, and water deprivation. In addition, visual detection performance is influenced by a factor called vigilence which accounts for the decrease in the alertness of patrol members as a function of the time they have been conducting stationary reconnaissance operations. If the patrol is stationary, this calculation is also made as shown in Figure 2.31.

2.4.10 External Communications

The External Communications Subroutine shown in Figure 2.32 calculates an external communication verdict for the patrol on each communication attempt. First, the total ampere hours currently available to the patrol are computed to determine if the battery life is expended. If so, a nocommunication verdict is returned by the subroutine. If power is available, then a power budget analysis is conducted; and vegetation, defraction, and space losses are computed. These calculations depend upon the current distance from the patrol to the base and the terrain between SIAF and the base. The results of this power budget are used to compute the signal-tonoise ratio at the receiver. This signal-to-noise ratio is then used to compute message intelligibility. As shown in Figure 2.32, the model simulates the actions of the patrol repeating the message until the intelligibility criteria (a user input) is satisfied. If the intelligibility criteria is not satisfied with N trials (N is a user input), then a nocommunications verdict is returned by the subroutine. If the criteria is satisfied, then the communication is said to be successful.

2.4.11 Command and Control

The current SIAF command and control model consists of a movement command and control subroutine (described in Section 9.1) and a post detection decision subroutine (Section 9.2).

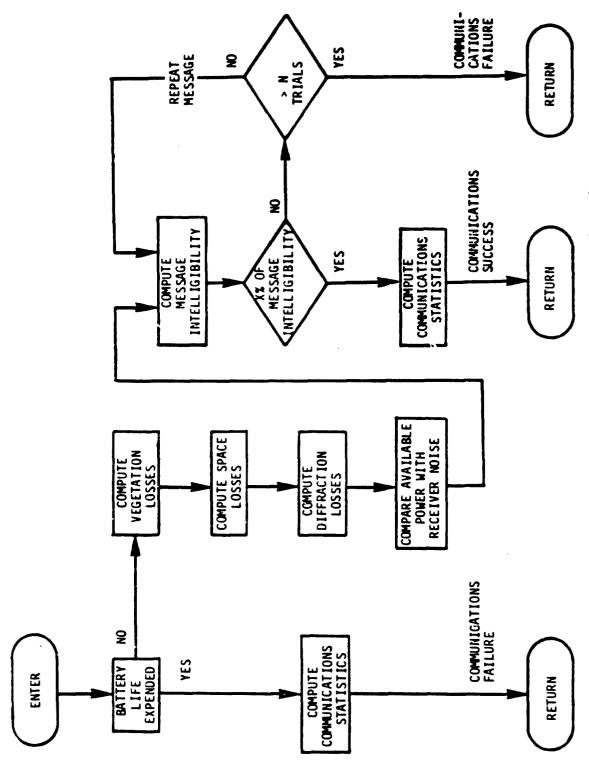


Figure 2.32, External Communications Subroutine (EXCOM)

With respect to patrol movement, the required movement rate which a patrol must sustain in order to arrive at a next checkpoint on time is compared with a desired movement rate that is consistent with being able to maintain good surveillance. If the required rate exceeds the desired rate, trade-offs are made between time and detection performance to select the most satisfactory movement rate for the patrol. The trade-off results can be controlled by adjusting input weighting factors.

In the post detection subroutine of Section 9.2, alternatives are provided which cause the patrol to move along a dynamic route toward the target to identify it or to move around the target to avoid it. Logic is also provided for calling external fire support on targets. Input variables are provided which allow the user the capability of exercising these model options (see Section 9.0 for details).

2.5 SIAF COMBAT SUBROUTINES

Thus far an overview of the reconnaissance model has been presented in previous sections. Once the SIAF patrol detects a target, however, it may decide to combat the target, and once the combat is completed the patrol may decide to continue the reconnaissance mission. The SIAF model considers these possibilities. In the following section an overview of the combat decision and execution subroutines are presented. (Details of these routines are described in Volumes V and VI.) Included is a description of the decision logic and decision optimization routines, and a discussion of the combat executive routine. Finally an overview of the withdrawal and the continue mission routine which allows the patrol to continue on its reconnaissance mission once the combat operating is completed, is presented.

2.5.1 Combat Decision Logic and Optimization Logic

In the SIAF reconnaissance model many detection and identification possibilities exist. For example, the SIAF patrol could possibly identify two targets simultaneously or several targets could identify and detect SIAF at the same time. Because of the complications involved in developing logic to model these situations, combat operations where more than one target is involved are not considered in the model. Instead if it turns out that several targets detect SIAF or SIAF has detected and identified several targets then a no combat decision is made and the SIAF patrol avoids the

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targets. Considering the fact that SIAF normally operates as an independent force this is probably a reasonable simulation of what they would in fact do. That is, should they detect and identify more than one target they would probably avoid the target area.

Now consider the case in the simulation model where SIAF detects and identifies a single target. In this case if its mission is combat, the patrol must decide what kind of combat action to initiate. Here decision logic is necessary since it is impossible to determine exactly where the patrol will be and exactly what and where the target is when the detection occurs during the simulation. Hence this logic dynamically examines the current tactical situation and selects a course of action. The movement to contact and deployment decision logic shown in Figure 2.33 indicates that five courses of action are possible. The first course of action is that the patrol could call in external fire support on the target. The second alternative is that the patrol could deploy for ambush. This alternative, for example, would probably be selected if the target were moving toward the SIAF patrol. On the other hand the target may be moving in a direction away from the patrol or may be out of range of the patrol. In this case the SIAF patrol could decide to move to a deployment position and call for external fire support if available, before initiating the fire fight. Another alternative, even before a detection occurs, is to move to an ambush area to deploy Claymore mines. The fifth alternative, of course, is a no combat decision. The decision logic subroutines examine the current tactical situation and select one of these alternatives based on the following decision variables.

- 1) Mission (ambush, attack, or deploy Claymore mines)
- 2) Force ratio (i.e., the relative size of the target vs the size of the SIAF)
- 3) SIAF-target range
- 4) Direction of travel of the target
- 5) The terrain between the SIAF patrol and the target as to its effects on cover, concealment, and observability.

The decision logic is constructed so that the user can adjust the input data and choose different criteria for selecting a course of action. Thus the decision variables are examined, the tactical situation determined by the model and a combat option is dynamically selected.

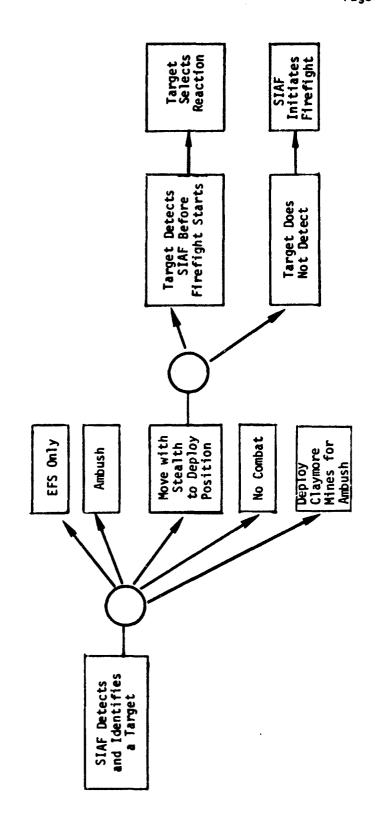


Figure 2.33, Movement to Contact and Deployment Logic

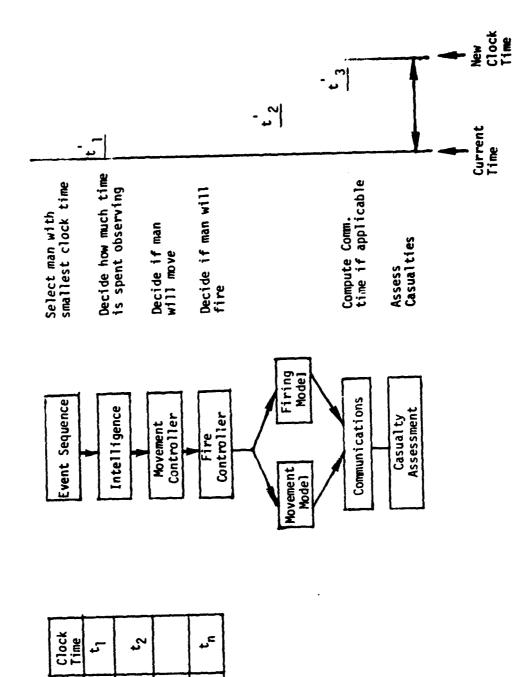
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In the case of external fire support only the external fire support (EFS) subroutine is then called, external fire support simulated, and the patrol then makes a "continue the mission" decision and would probably, in this case, decide to return to continue the reconnaissance patrol. In the case where deployment is selected, optimization logic uptimally selects the exact deployment position of each maneuver unit in the terrain. The most complicated situation evolves when the patrol decides to move to a denloyment position. In this case the dynamic route selector routine (DROUTE) selects movement points based upon different movement criteria which again are user input. As shown in Figure 2.33 when the patrol is involved in this type of a movement the target could possibly detect the patrol before the fire fight occurs. In this event the target could react by moving, deploying, or opening fire. If, on the other hand, the target does not detect the patrol in movement to the deployment position, SIAF initiates the fire fight. If the target should move toward a better defensive position, the SIAF may reselect its deployment points or exchange roles between maneuver units and and the base of fire. Thus, the combat decision and optimization logic provide a mechanism for the user to select various combat alternatives based upon the current tactical situation.

2.5.2 Combat Executive

In Section 2.3 the executive routine used to drive a reconnaisance model was described. In this section an overview of the executive routine used to drive the combat model is presented. In this regard two approaches for driving the combat executive routine were examined. The following section describes and compares these two approaches.

The first alternative shown in Figure 2.34 indicates that each man in this situation has a clock time, initial values of which are selected to be different based upon user input. The model selects the man with the smallest clock time and decides how much time is to be spent observing in an intelligence routine, and computes this amount of time (t_1' in the figure). Then movement and fire controller models decide if the man will move or fire. If he is to fire, for example, the fire controller model decides at whom he will fire and computes the firing time (t_2' in the figure). If communications are to occur the time required for communications are also computed. Finally casualty assessments are made. After these calculations are made the clock time for this particular individual examined



Man 2

Man 1

Man

Man n

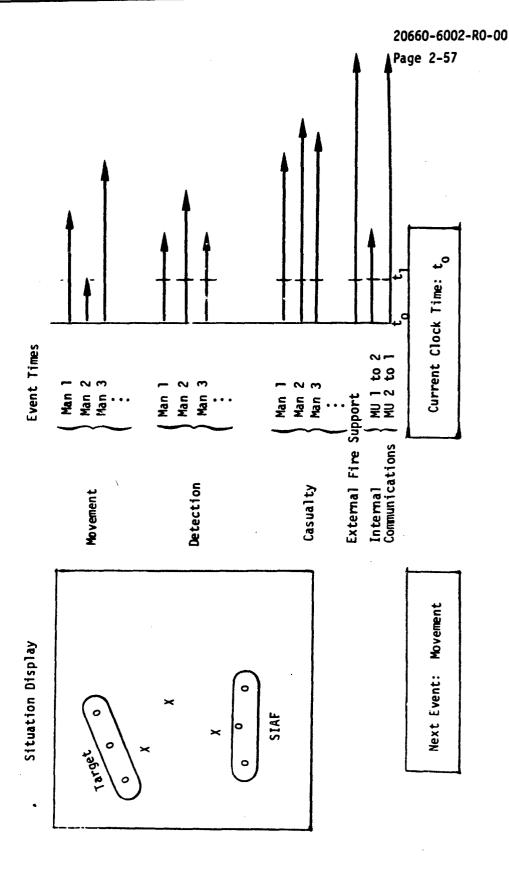
Figure 2.34, Alternative 1 to the Combat Executive

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is advanced by the amount $t'_1 + t'_2 + t'_3$ and he is given a new clock time. The model then scans the list of men and clock times, picks out the minimum, and repeats the procedure. Thus, in alternative one, each man is individually cycled through functions that he is required to perform during combat and time is advanced in the fashion described above. This is the approach that is used in models such as DYNTACS and ASARS.

An alternative to this approach is presented in Figure 2.35. Here, instead of individually selecting each man and having a clock time associated with each man, only one clock time exists in the model. The event times in this case are movement, detection, casualty, EFS burst, and internal message reception. The executive routine computes the movement and detection event times for each individual for both the attacker and defender, and the casualty times of each individual for both the attacker and defender. It then scans this list of times together with any scheduled arrival of EFS and any scheduled reception of a message between maneuver units. It then selects the minimum time, and defines the corresponding event as the event which occurs in this particular segment of the model. Figure 2.35, for example, illustrates what would happen if the event were movement. In this case, all moving individuals would be moved an appropriate amount of ammunition, the clock time and the status of each man would be updated, and calculations would be repeated. Thus, instead of cycling through each man, this particular method examines the next event to occur for all men, advances the clock time based upon the minimum of these times, and updates the attributes of each man to what they would be at this time.

A comparison of these two approaches is shown in Figure 2.36 and here, three attributes were defined: running time, event accuracy, and capability to handle cumulative interactions. The comparison indicates that alternative one probably has a faster running time in most cases. However, arguments that alternative two could be faster are also possible to evolve. As far as event accuracy is concerned, alternative one could possibly neglect events which occur to other individuals during a given loop through the logic. The reason for this can be seen through a further examination of Figure 2.34 which shows that an individual could possibly become a casualty during the advance of his clock time. Thus, unless a time step variable is set to adjust the advance of



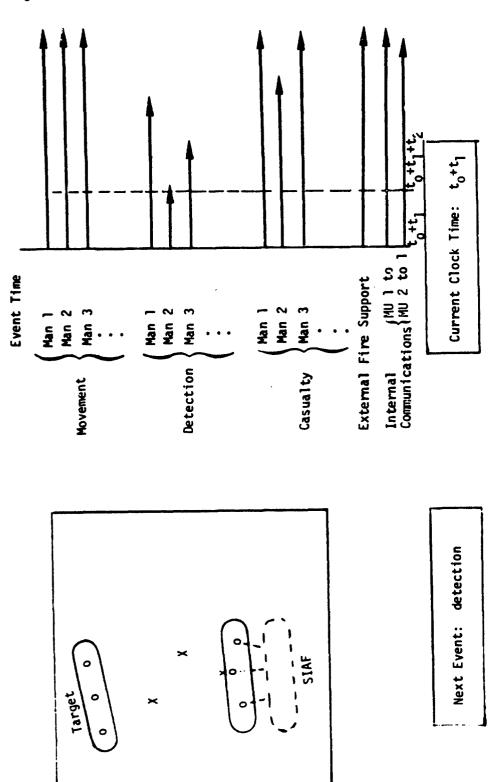


Figure 2.35, Alternative 2 to the Combat Executive (Sheet 2)

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Attribute	Alternative l	Alternative 2. SIAF Technique
Running time	Faster running time in most cases	Will normally run longer but could run faster than Alt. 1
Event Accuracy	Could neglect events which occur to other individuals during a given loop through the logic	Such events are not neglected since everyone is upcated during each advance of the clock
Capacity to handle cumulative interaction	Suppression only considers one man firing at one and neglects simultaneous firing	Suppression includes the effect of many individuals firing at one (rumulative P _K table)

Figure 2.36, Comparison of Executive Alternatives

the clock, these types of events, which would tend to bias the results, could occur. With alternative two, such events are not neglected since the time of the first event for all individuals is first calculated and time is advanced in a fashion previously described. With respect to cumulative effects, alternative one neglects the fact that the suppression of an individual may be greater because three individuals may be firing at him rather than just one. Alternative two, on the other hand, can include these types of cumulative effects. As far as implementation goes, it is not clear that alternative one is superior to alternative two. Different logic is required for both alternatives, and a comparison is very difficult to make. Based upon the manner in which the reconnaissance model currently runs and an examination of these alternatives, alternative two was selected as the technique to be used for the SIAF combat model.

In summary, two executive routines are provided with the SIAF model. The first is the reconnaissance executive which operates in the manner described in Section 2.3. Once the detection and identification occurs the decision logic determines whether a combat action will occur. If a combat is to occur then the combat executive described above simulates this part of the mission. Once a combat mission is concluded and a decision is made to return to the reconnaissance operation, the reconnaissance executive routine described in Section 2.3 takes over and continues driving the model.

2.5.3 Data Structure and Manipulation

The SIAF combat model consists of a series of subroutines and an executive routine. The executive routine advances time in the manner previously described and calls individual subroutines to make various calculations. Interactions are considered and modeled by the subroutines which essentially update the attribute list of the target and SIAF shown in Figure 2.37. For example, ATT(1,1,1) is the fire team number of the first man in the attacker patrol. ATT(3,2,2) contains a value of the number of rounds remaining for man number 2 in the defender unit. The attribute matrix is a 25 x 20 x 2 matrix, and the attributes of each individual are changed by various subroutines depending upon the situation. For example, should movement occur then the current X and Y coordinates, attributes 7 and 8, of each individual involved in the movement are updated by the appropriate routine. Should a patrol member assume a different posture, then the height of the patrol member is

X is the Attribute of the Patrol Member	1: Team Number	2: Weapon Number	Current Ammunition Supply (Rounds)	4: Casualty Status	Firing Status	6: Current Suppression State	7: Current x Coordinate (Meters)	Current y Coordinate (Meters)	9: Next x Coordinate (Meters)	10: Next y Coordinate (Meters
k is the	<u>::</u>	2:	 	4:	5:	9:	7:		.6	10:
Z is the Patrol Identifier	1: Attacker	2: Defender		Y is the Patrol Member						
is th	_	8		is ti	-	2	m	•	•	•
7				>						

ATT(X,Y,Z)

17: Function in Patrol18: Movement Rate of Each Individual19: Individual's Assignment

Maneuver Unit to Which the Element Belongs Number of Rounds Remaining in Magazine

Current Posture

Width (Meters)

Moving Element

Height (Meters)

20

20: Initial Ammunition Supply21: Weapon Type22: Position in Fire Team

23: Secondary Weapon Number24: Hand Grenade Supply25: Signal Grenade Supply

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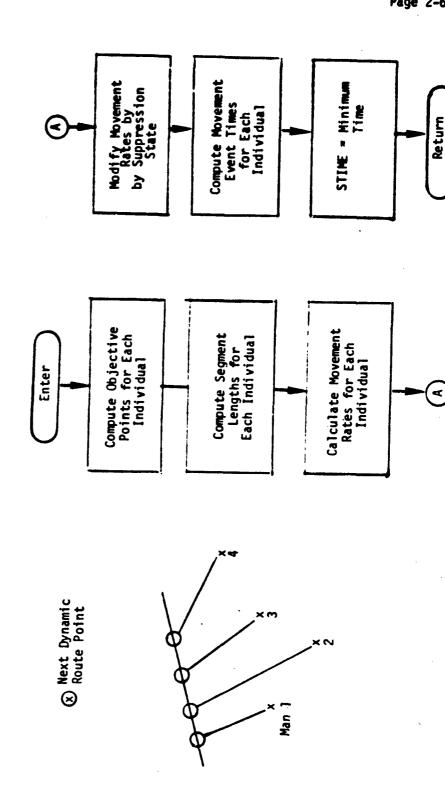
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adjusted, attribute No. 11. Should his movement status change, for example, should he be in a suppression state where movement is not allowed, then the movement status attribute is changed. Attribute changes by one routine in turn effect other routines. For example, should the movement status change, the firing status would probably be different to allow the advancing unit to start moving again. Hence, the interactions between routines are essentially communicated to each of the routines through the attribute matrix. Naturally this is an oversimplification of the exact details of the model and is intended to be an overview to aid in understanding the details presented in Volumes V and VI.

2.5.4 Calculation of Movement Event Times

As previously described in Section 2.5.2 five events are defined in the executive: movement times, detection times, casualty times, communication arrival times, and EFS burst event times. This section describes the calculation of movement event times. Figure 2.36 illustrates this calculation and shows the SIAF team in a line formation moving from one objective point to the next objective point which in this case is the point generated by a dynamic route subroutine. The model starts by computing the objective point for each individual based upon its formation of the unit. For a line formation the objective points would be as shown in the figure. If the formation were a "V" or a wedge then subroutine FORMST would compute the appropriate objective points for each individual and load these values into the ATT matrix. Specifically, these values would be located in ATT 9 and 10, the next movement coordinates. Next, based upon the present location of each individual, this subroutine calculates segment lengths for each individual. As shown in the figure, the segment lengths for each individual could be different and the path each individual takes could be over different terrain; hence, the movement rate model described previously in the reconnaissance section is called and the movement rate of each individual over each seqmert is calculated. Next these movement rates are modified by the current suppression state which is stored in the ATT matrix. Finally, the segment lengths are divided by movement rates to compute the time at which each individual would reach its next objective point. Then the minimum of all these times is calculated and stored in a variable called STIME.





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2.5.5 <u>Calculation of Detection Event Times</u>

The previous section described how movement event times are calculated. In this section the calculation of detection event times is described and illustrated in Figure 2.39. First a specific SIAF and target individual are selected. Here detection times are based upon individual detections on individuals, that is, if there are 20 members in a SIAF patrol and 20 members in a target then there are 400 calculations made. After a SIAF individual and target individual are selected the terrain routines are entered and calculations made to determine if line-of-sight exists. If line-of-sight does not exist a no-detection verdict is entered. If lineof-sight does exist and the target is firing then the target is declared detected and time of detection is stored in the array DTIME as shown in the figure. Here the value of DTIME is the current time plus the reaction time which is the time it takes the individual to react to the detection and either change his posture, firing option, movement rate, or change another of his attributes based upon this detection. As shown in the figure, if line-of-sight exists but the target is not firing then a visual detection subroutine is entered to calculate the visual detection time TI. This routine is similar to the routine used in the reconnaissance model described in Volume III. Based upon this calculation the matrix DTIME is again loaded. Finally, the DTIME plus a maximum time are compared with the current time to allow for considering the fact that an individual might have detected another individual 5 seconds ago and the detection may still be valid. As shown in the figure the variable MDET is set equal to TRUE or FALSE which indicates whether the detection did or did not occur. The model proceeds in this fashion until all individuals in the SIAF patrol and all individuals in the target have been examined for detection.

2.5.6 Calculation of Casualty Event Times

Figure 2.40 describes this calculation which starts with computing the assigned area of responsibility of each individual. From this information the next calculation essentially determines a figure of merit and determines firing assignments which will maximize this figure of merit. Thus, this calculation determines the optimum strategy for the

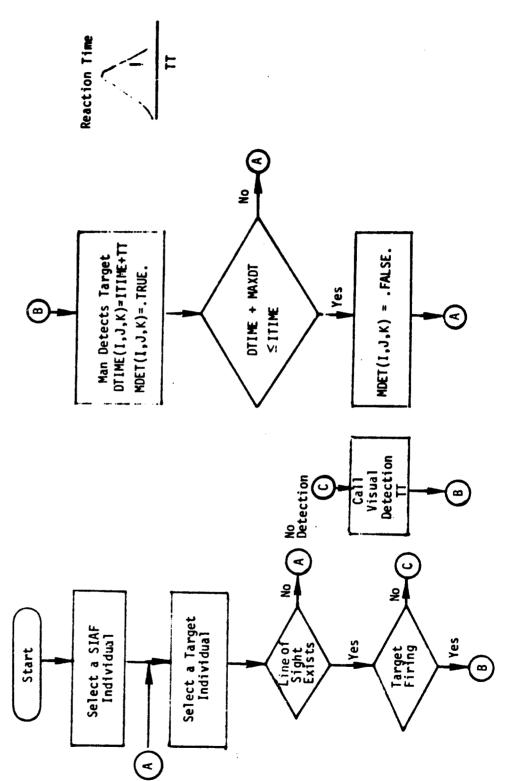


Figure 2.39, Calculation of Detection Events

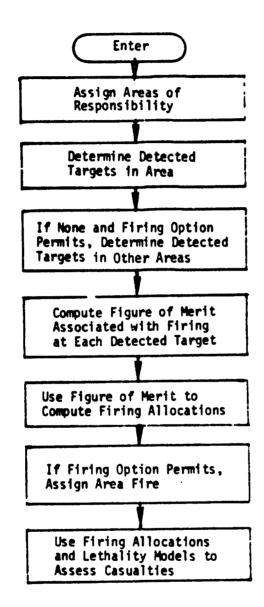


Figure 2.40, Calculation of Firing Events

target and SIAF patrol to use in firing. Based upon this optimum strategy, firing allocation and lethality models are entered to compute casualty times.

2.5.7 <u>Calculation of Internal Communication Event Times</u>

One of the events considered is the reception of a communication from another maneuver unit within the patrol. This would occur after deployment when units are divided into moving maneuver units and a base of fire. In this case it may be necessary to communicate decisions such as break contact, change deployment points, or exchange roles between the moving units and the base of fire. The latter two would be in response to a reaction of the target such as a change in its route or deployment. Several options are available to provide communications. These are by visual hand signals, aural commands, radio, smoke grenades and by sending a messenger. For each type of message, the model has a preference order for attempting communication. These are dependent on the tactical situation. The internal communications routines, called by IC, determine whether or not the communication will be successfully received and interpreted, and they determine the delay time until the message can be implemented. The delay time becomes an event time because the result affects further progress of the combat, including firing, detection and movement status.

2.5.8 Calculation of External Fire Support Event Times

The fifth event considered is an External Fire Support (EFS) event. This is defined as the arrival of a burst, either a volley of artillery or the weapons dropped in a single pass of a close air support aircraft. EFS is a scheduled event but its execution depends on the tactical situation. It is used preparatory to an attack mission. Upon identification of the target, the aimpoint is communicated and a schedule of arrivals is determined. If the target has not counterdetected the SIAF, then the arrivals are scheduled such that they are finished at the same time that the target reaches the minimum safe distance from the target. If this is the case, but the target subsequently counterdetects the SIAF, an immediate open fire command is sent and the schedule of arrivals is adjusted

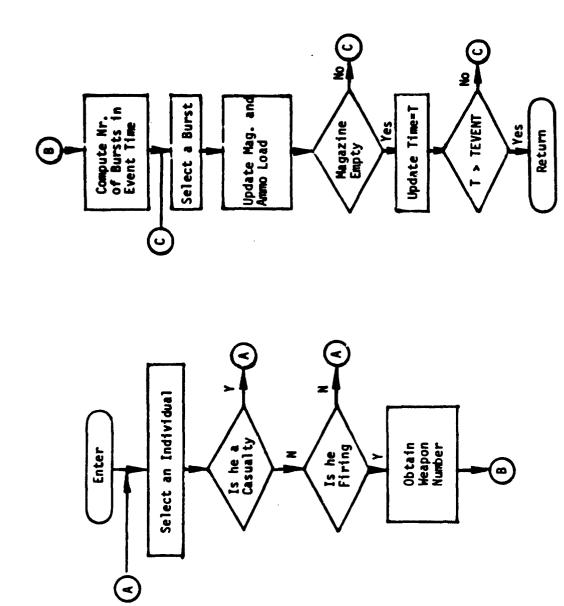


Figure 2.41, Ammunition Update Subroutine (AMMOUP)

to start after a delay due to communications and time of flight. If the target has counterdetected the SIAF at the time of the original request, the delay time also includes time to make aiming calculations and to aim the weapons.

If external fire support is the next event, then Subroutine EFS1 is entered to compute the casualties due to each bomb or shell. This is done by considering aim point errors due to the inability of the SIAF to exactly determine the grid coordinates of the target. This includes both navigation errors and target location estimation errors. Also considered is the ballistic dispersion error. Once the aimpoint is determined (stochastically), the distance of each individual is determined and compared to the lethality data for the weapon. The attribute table is updated to account for any casualties.

Once these times are calculated the next event to occur be it movement, detection, casualty, EFS, or internal communication can be computed. If, for example, it is a movement event then the individuals are moved by updating the ATT matrix. If the next event is a detection event the corresponding logic is entered which will modify the movement rates and firing options based upon these detections. If, on the other hand, the next event was a casualty event then the appropriate element in the ATT matrix are updated to indicate that the individual has become a casualty. After these series of calculations are made the ammunition update, weapon substitution, break contact, and withdrawal routines are entered as appropriate. These routines are described in the next sections.

2.5.9 Ammunition Update

The purpose of this subroutine is to update the ammunition of each individual based upon the current elapsed time and the firing scheme. This routine is described in Figure 2.41 which shows that the first calculation is to select an individual. Next, the question is asked, "is he a casualty?" If so, his ammunition is not updated since he could not have been firing. Hence, another individual is selected and the calculations proceed. If he is not a casualty and if he is firing then his weapon number is obtained from the ATT matrix and the number of bursts in the current event time are computed for this particular weapon and particular

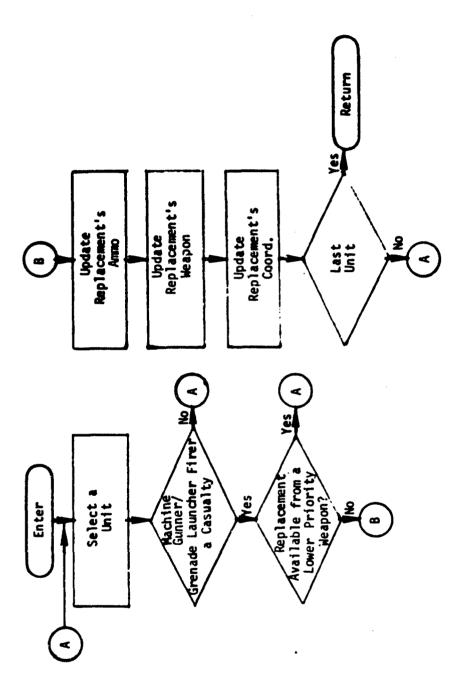


Figure 2.42, Weapon Substitution Subroutine (WSUBS)

Table 2-1, Firing Options

Firing Options

8 0 Fire at detected targets in area of responsibility If none, conduct area fire into area of responsibility If none, fire at any detected targets Don't fire Maneuver Unit

Table 2-2, Firing Options for the Base of Fire and the Maneuver Unit

Base of Fire

						L
SSMU	0	_	2	3	+	Ψ,
Firing Option	0	0	0	0	2	

1	 -						
9	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2
4	4	4	Þ	4	4	2	2
3	ı	1	_	-	J	2	2
2	ı	1	_	_	1	2	2
_	١	ı	_	_	-	2	2
0	1	1		-	-	2	2
SS _{BF}	0	-	2	Е	4	S	9

SS_{BF} = Suppression State for the Base of Fire SS_{MU} = Suppression State for the Maneuver Unit

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firing rate of the individual. It could turn out that during the event time the magazine of the weapon became empty. Hence, the next series of calculations determines whether this occurred. If the magazine does become empty reloading time is entered into the calculation and modifies the number of rounds that the individual expended during the last event. If the magazine did not become empty, then number of rounds are computed based upon the event time and firing rate of the weapon. These calculations are done for each individual and the subroutine returns when all individuals have been examined.

2.5.10 Weapon Substitution

If an individual becomes a casualty (major wound or death) in a particular event, it could turn out that the patrol operations plan is to have another individual take over his weapon. This normally occurs in a case of team weapons like grenade launchers, and machine guns. If the machine gunner is hit a patrol member who fires a rifle or grenade launcher will take over his weapon. An attempt to replace him with a rifleman is made first. If the man who is hit fires a grenade launcher an attempt is made to replace him with a rifleman only. Subroutine WSUBS provides the logic implementing this strategy. Figure 2.42 illustrates the calculations made. First, a unit is selected and here the assumption is that intra-unit weapon substitution is not allowed. That is, weapon substitution is only allowed within a particular unit. After a unit is selected the question is asked if the gunner who is a casualty fires a machine gun or a grenade launcher. If not, another unit is selected and this unit selection process continues until the number of units in a patrol and target are exhausted. If the patrol member under consideration is a casualty and is either a machine gunner or fires a grenade launcher and an appropriate replacement can be found then the ammunition of the replacement is updated, his weapon is switched and his next movement coordinates are changed. These calculations continue until all units have been examined for weapon substitution. (Note: If the user does not desire to play weapon substitution, this subroutine can be bypassed by appropriately adjusting the input variables. This is described further in Volume VI, Subroutine WSUBS.)

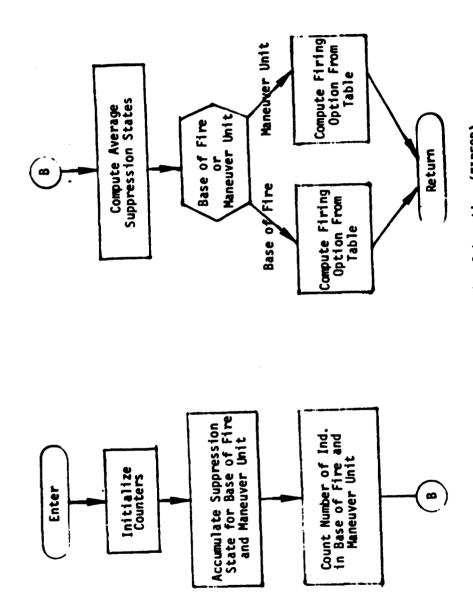


Figure 2.43, Firing Option Subroutine (FIREOP)

Table 2-3, Logic for Breaking Contact

Break Variable	Definition	Criteria
Firebower	FP = Firepower of Target Firepower of SIAF	Break if FP > FP _{Max}
Casualty Fraction	CF = SIAF Casualties	Break if CF > CF _{Ma}
Time	T = Elapsed time of the firefight	Break if T>T _{lim}
Loss of Key Personnel	$L_i=1$ if the PL is hit $L_i=2$ if the PL and APL are hit	Break if L _i = j (j = 1 or 2)
SIAF - Target Range	R = Minimum Distance Between SIAF and Target	Break if R <r<sub>lim</r<sub>
Ammunition	A = Average Number of Rounds Remaining (per troop)	Break if A< A _{lim}

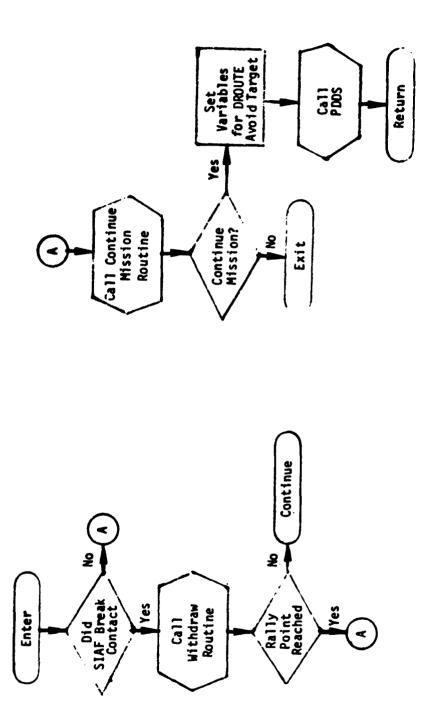


Figure 2.44, Logic For Continuing Reconnaissance After Combat

2.5.11 Firing Options

1

This particular section describes and presents an overview of how firing options are changed dynamically throughout the conduct of the simulation. Table 2-1 shows the firing options considered in the model. For example, Firing Option 0 is simply "don't fire". Firing Option 1 says, "fire if targets are in your area of responsibility. If none, then don't fire". Option 2 says "fire if detected targets are in area of responsibility. If none, then conduct area fire in area of responsibility." Options 3 and 4 are similar and can be examined by studying Table 2-1. Table 2-2 shows the firing options of both the base of fire and maneuver unit and here the numbers correspond to the options previously described in Table 2-1. For the base of fire, the firing option is a function of their own suppression state and the suppression state of the maneuver unit since their mission is to support the advance of the maneuver unit. The firing options of the maneuver unit on the other hand is a function of their own suppression state only. As an example, Table 2-2 shows that if the maneuver unit in suppression state 0 through 3 their firing option is O, that is "don't fire". If they are in suppression state 4, 5, or 6, however, their firing option is firing option 2 which states fire at detected targets in area of responsibility. Hence, the firing options can be changed for the base of fire and the maneuver unit by user input data depending upon which particular strategy the user wishes to simulate.

Figure 2.43 shows how this logic is implemented in subroutine FIREOP. When the subroutine is entered counters are initialized and the suppression state for all individuals in the base of fire and maneuver unit is accumulated. Next the number of individuals in the base of fire and maneuver units are counted and the average suppression state of each of these units is computed. Table 2-2 is entered and the appropriate firing option computed by means f table look-up. In this fashion the firing options of both the base of fire and maneuver unit are dynamically adjusted throughout the execution of the combat mission.

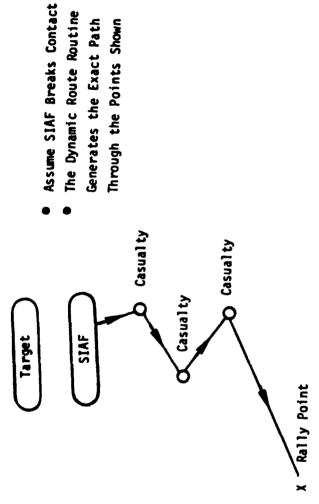


Figure 2.45, Illustration of Withdrawal Model

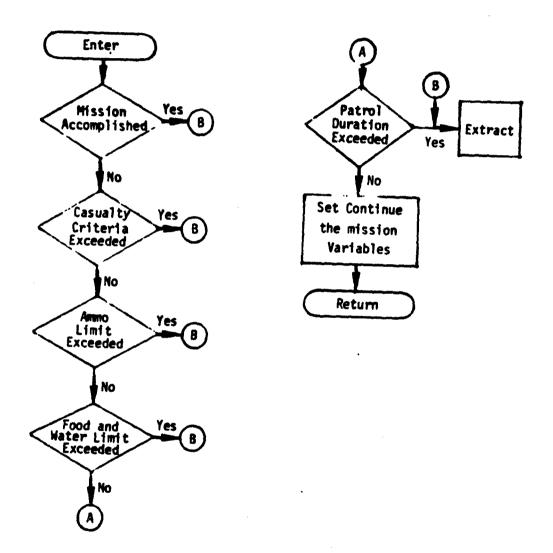


Figure 2.46, Continue The Mission Subroutine

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This firer also has the option of firing his normally assigned weapon or throwing a handgrenade. Dependent upon the figure of merit calculated for both his normally assigned weapon and a handgrenade, for the situation that the firer under consideration is in, a decision is made as to which weapon to utilize. The handgrenade is basically used at short ranges under high suppression.

2.5.12 Mines

A SIAF patrol has the capability of Claymore mine ambush. Figure 2.46A depicts a typical mine field deployment. The user specifies a Claymore mine ambush intent by inputting the required inputs, and upon the enemy patrol reaching the most lethal point in the field (middlemost) the mines are detonated. The cumulative probability of kill of all mines in the field upon each target element is computed and the cumulative probability is Monte Carloed for each target individually to determine if the target suffered a minor wound (hit), major wound, or death. Figure 2-46-B shows how this logic is implemented in Subroutine MINES.

2.5.13 Break Contract

In each loop of the simulation, logic for breaking contact is entered if a break contact event is to occur and if so, a determination is made as to which side breaks contact. The break variables described in Table 2-3 are fire power, casualty fraction, time, loss of key personnel, SIAF-target range and ammunition. The criteria for breaking contact are adjusted by means of user input for both the SIAF patrol and for the target. For example, if the user wishes to implement a strategy whereby the SIAF patrol breaks contact after their ammunition reaches 30% of the initial load they implement this strategy by appropriately adjusting the ammunition limit variable shown in the table. The other criteria shown in the table are used in a similar manner. The break contact logic implements a break contact decision if any of the criteria are satisfied.

2.5.14 Withdraw

Figures 2.44 through 2.46 describe how we model a situation where SIAF returns to its reconnaissance mission after the combat operation has been completed. As seen from Figure 2.44, this routine is entered once the proper break contact variable has been set. The first question asked

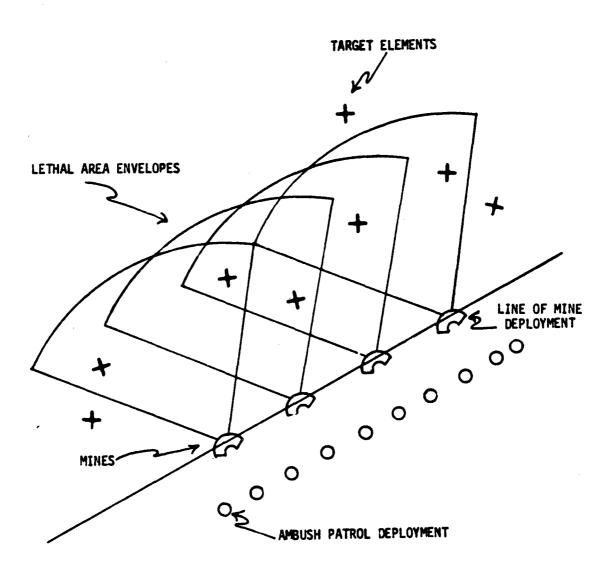


Figure 2.46A Typical Minefield Deployment

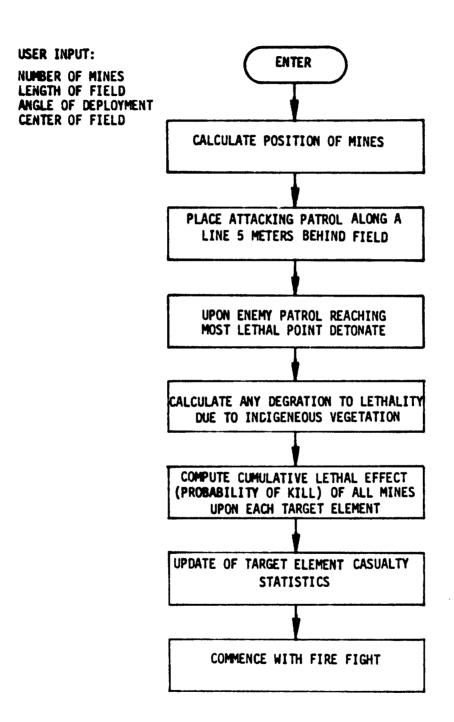


Figure 2.46B, Logic Diagram (MINES)

is, "did SIAF break contact?". If not, then no withdrawal is required for the SIAF unit and the continue-the-mission subroutine described in Figure 2-46 is entered. If SIAF did decide to break contact, then a withdrawal routine is entered. This withdrawal routine calculates the major withdrawal objective points for the patrol. Next, the withdrawal is simulated until the rally point is reached. Once the rally point is reached, the continue-the-mission decision subroutine is entered and if the decision is to continue the mission, then dynamic route variables are set up to avoid the target and get the patrol back to the planned route.

Figure 2.45 illustrates the withdrawal model which forces the patrol to pass through points where a casualty has occurred to the rally point. As indicated in Figure 2.45 the dynamic route subroutine is called to generate the exact route through the casualty locations to the rally point.

2.5.15 Continue the Mission

Once the rally point is reached, the continue-the-mission subroutine shown in Figure 2.46 simulates the patrol leader's decision to extract or go hack to the planned route. This decision is based upon the variables shown which are mission objective, casualty criteria, ammunition limits, food and water limits, and patrol duration limits. By adjusting these limits which are user input values, the user can select the criteria he wishes to use in simulating the decision to continue the mission or extract. If a continue-the-mission decision is reached, dynamic route variables are set and subroutine PDDS (see Volume III) is called to generate the route back to the planned path. If the decision is to extract then the model terminates and variables are initiated for the next replication.

2.5.16 Summary of Attacker and Defender Options

Prior to a detection occurring, the SIAF Reconnaissance Model simu-Itates the SIAF mission as discussed in Section 2.4. Once a detection and identification is made (either by SIAF or by the target), the party making the detection and identification becomes the attacker and the other party becomes the defender.

As discussed in Section 2.5.1, the attacker will select one of five options, viz, 1) EES only, 2) ambush, 3) move with stealth to attack, 4) deploy for ambush with mines, 5) no combat. Meanwhile, the defender, having not yet detected, continues to move along his preplanned route. If the attacker selects options 2 or 3, a deployment point is computed and the dynamic route routine generates the attacker's route between his present position and the deployment point. If the defender detects the attacker before the attacker initiates the firefight, then the defender initiates the firefight or selects an alternative course of action to protect its position.

Once the firefight commences, the defender remains stationary unless he decides to break contact. If the target decides to break contact, the engagement is considered complete and SIAF decides whether to continue its mission. However, if SIAF decides to break contact, the withdrawal is simulated until the rally point is reached, at which point SIAF decides whether to continue its mission, in which case the SIAF Reconnaissance Model is again employed to simulate the remainder of the mission.

2.5.17 Summary of Model Capacities

This section summarizes the current capacities of the model. A summary of computer requirements is given in Sections 7.1 and 7.2 of this volume.

- Maximum number of men on each side = 20
- Maximum number of different weapons = 20
- Maximum number of different grenade launches = 10
- Maximum grid of terrain elevation points = 1366
- Maximum number of targets = 20
- Maximum number of preplanned route points for each target = 20 Maximum number of preplanned SIAF route points = 100 Maximum number of helicopter landing points = 5

- Maximum number of weather changes = 100
- Maximum length of simulated patrol = 10 days

3.0 MODEL INPUT

The model input data consists of users inputs, data base, and elevation data. The elevation data is taken directly from digital TOPOCOM tapes from the Defense Mapping Agency. When a particular area of operations is desired, a set of subroutines is used to generate a file of elevation data which can be permanently stored. This file can then be accessed at the start of each run as long as the area of operations remains the same. This file contains elevation data at the maximum resolution (or minimum separation). The model then reads from this file to obtain data for the required resolution. The maximum elevation points at any one time is 8196.

The remaining data inputs are read via NAMELIST card input. In general, the namelist card input has been organized into categories of data base (NAML1), user input (NAML2), target oriented user inputs, (NAML3), and combat oriented user inputs (NAML4). Table 3.1 contains a complete list and definition of all of the required input variables. This table is organized by first presenting user inputs, (those variables specific to a situation) and then presenting the data base. (Variables whose values are unlikely to change from run to run). Within these categories the data is organized by categories according to the use of the variables. For example, all of the required inputs to describe the targets are found together.

The variables in the data base are further described by default values which are current best estimates. These need only be changed if better data become available.

Table 3.2 contains a cross reference to Table 3.1. Here all variables from the namelists are presented in alphabetical order with the sheet number of the corresponding location in Table 3.1. It is felt that this method of presentation allows the user to better understand the meaning of a variable because he is able to see its definition in the context of other variables with which it is associated.

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USER INPUT

SET UP

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THEATA Angle between the X axis SIAF computer coordinate system and military grids WH X coordinate of origin of SIAF computer coordinate system in the military grid system
VK Y Coordinate of origin of SIAF computer coordinate

Table 3-1, Namelist Inputs (Sheet 1)

TERRAIN (Continued)

COMRES	Combat resolution for elevation array (Distance between grid lines)	meters (12.7)	
RECRES	Reconnaissance resolution for elevation array (Dis- meters (50.8) tance between grid lines)	meters (50.8)	
RESMAX	Maximum resolution available for elevation array	meters (12.7)	
IXMAT	Number of scan lines in input Z matrix (output from MAPGEN) (See Vol. III, Section 10.5)	•	
IYMAT	Number of elevation points per scan line		
IDOMST	Dominant soil type		
DOMBAT	Dominant class of micro-relief		
DOMV	Dominant class of vegetation		
NOB	Total number of linear obstacles		
NRVP	Total number of vegetation polygons		
NRMT	Total number of micro-relief polygons		
NRST	Total number of soil polygons		
LNR!	The integer number designating the first linear obstacle		
VEG1	The integer number designating the first vegetation polygon		
17108	The integer number designating the first micro- relief polygon		

Table 3-1, Namelist Inputs (Sheet 2)

IERRAIN (Continued)

The integer number designating the first soil polygon	Linear obstacle type; for L=1,2,3,NOB where IOB(L) = 1 if linear obstacle L is a river 2 if linear obstacle L is a ravine 4 if linear obstacle L is a dike 5 if linear obstacle L is a canal 6 if linear obstacle L is a canal 7 if linear obstacle L is a canal 8 if linear obstacle L is a toad 9 if linear obstacle L is a trail 9 if linear obstacle L is a lake or reservoir	Geometry of L th polygon, where l if L th polygon is a riangle 2 if L th polygon is a rectangle 3 if L th polygon is a circle for L ⁼ 1,2,3, NRVP+NRMP+NRSOIL	Coordinates of start point of segment I of obstacle L, for L=1,2,,NOB, and I=1,2, (NCO(L)+1) or coordinates describing the geometry of the L th polygon	Number of line segments comprising linear obstacle L, for L=1,2,3,NOB	Class of the L th polygon, for L=1,2,NRVP+ NRMP+NRSOIL
MICRI	10B(L)	ITRC(L)	(x0B(I,L), Y0B(I,L))	NCO(L)	וכר(ר)

Table 3-1, Namelist Inputs (Sheet 3)

NAVIGATION DEVICES

Portable Position Location System. If such a device is carried by SIAF, PPLS=1, if not carried by SIAF, set PPLS=0.

PPLS

TBUR

Set TBUR=0 if it is impracticable to use PPLS or if sufficient time is not available. TBUR=1 if sufficient time is available only for a "quick" navigation fix. (2 min. after aircraft arrival, CEP=150.) TBUR=2 if sufficient time (15 min.) is available for an accurate navigational fix (CEP=60 meters).

Map Scale

SCALE

SPEC

Special Case. Allows override of HumRRO SIAF navigation specs. Input revised limit on standard deviation of distance between actual SIAF location and believed SIAF location. (HumRRO nav. specs. are used if SPEC is input as zero.)

Table 3-1, Namelist Inputs (Sheet 4)

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meters

Average height of a SIAF element

Sc(1)

SC(2)

SC(4)

SC(5)

SC(6)

IFS

meters

SIAF INPUTS

DESCRIPTION

						~_	_	
		۳.			\$	2		
		215	ē	4	15	**	L	
	5	~	蕉		 •	~	5	
e lemen	AF patro	rity of	SIAF me	depende	number	number	number	
Average width of a SIAF element	Number of men in the SIAF patrol	Average visual reflectivity of a SIAF element	Hearing threshold for a SIAF member	O if a vegetation class dependent formation is to be used for SIAF	if specific formation number 1 is to be used for SIAF	2 if specific formation number 2 is to be used for SIAF	5 if specific formation number 5 is to be used for SIAF	(See FORMATIONS)
9	ř	9 =	g	a de C	Spe	Sper	s pe	FOR
Vera	QU.	Average element	eari	₽or	= 2	# 2	‡ 9	4
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8

For Reconnaissance (See DETECT)

OPERATIONS PLAN

(See FORMATIONS)

- 4-digit military orid	- 4-digit military grid	- days, hrs, min, sec.
X coordinate of base.	Y coordinate of base	Time mission starts from base.
XBASE	YBASE	ITZERO

Table 3-1, Namelist Inputs (Sheet 5)

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<u> </u>
IMPUTS
SIAF

ITMAX	Limiting value on patrol time duration (used as temporary checkout input)	- days, hrs, min, sec.
	INSERTION	
MODE	Insertion vehicle description (1 = helo, 2 = truck, 3 = boat, 4 = fixed wing).	
TDEBK(MODE)	Average time to debark, for M = insertion - travel mode.	days, hrs, min, sec.
VELM(MODE)	Average velocity of the insertion travel mode over the terrain from base to insertion point.	meters/sec
TPREP	Time necessary to complete prep firing (i.e., - seconds time enemy has to move toward primary landing zone).	seconds
NLZ	Number of landing zones	
XLZ(1)	X coordinate of the I th landing zone.	4-digit
۲۲۵(۱)	Y coordinate of the I th landing zone	military grid 4-digit
PLZ(12)	Radius of landing zone IZ	military grid meters
NDECOY	Number of alternate landing zones (sequentially numbered) that are used for deceptive landings in addition to the actual landing zone attempt at the primary site. This dilutes the enemy in the area of actual landing. This number must be less than or equal to (NLZ-1).	

Table 3-1, .damelist Inputs (Sheet 6)

Page 3- Revised	B Decembe	r 197	73	- meters		•	- 4-digit military orid	- 4-digit military orid	- days, hrs, min, sec.	- days, hrs, min, sec.
0 if LZ sensors are not used before landing attempt lif LZ sensors are used before landing attempt	Number of LZ's seeded with sensors (seeding proceeds sequentially starting with the primary LZ)	Time before landing that sensors are monitored.	Number of sensors in each LZ (each individual LZ has the same number of sensors)	Range within which the enemy may engage the SIAF upon attempting insertion	ROUTE	Number of coordinate points for the planned route for insertion IZ	χ axis of the ${\rm IP}^{{\sf th}}$ checkpoint of the planned route when the insertion is made at point IZ.	Y axis of the Ip th checkpoint of the planned route when the insertion is made at point IZ.	Planned arrival time at checkpoint IP when insertion is made at point IZ (equals zero if this time is not pertinent).	Mission elapsed time to remain at non-movement point of IPth checkpoint for insertion point IZ.
ISEN	ISENLZ	HLZ	NSENS	ENRNG		NPLAN(IZ)	XPLAN(IP,IZ)	YPLAN(IP,IZ)	ITARIV(IP,IZ)	ITSTAY(IP,IZ)

Table 3-1, ..amelist Inputs (Sheet 7)

Table 3-1, Namelist Inputs (Sheet 8)

SIAF INPUTS (Continued)

- days, hrs, min, sec.		er. - days, hrs, min, sec. - days, hrs, min, sec.		
O if route checkpoint IP for insertion point IZ is not a non-movement point I if route checkpoint IP for insertion point IZ is a non-movement point Planned departure time from checkpoint IP for insertion point IZ.	TARGET IMPUTS Total number of targets	(Others located randomly) Time when target IT is created in the model days, hrs, min, sec. Time when target IT is eliminated from the - days, hrs, min, sec. model.	l if target IT is to be considered on an element-to-element basis O otherwise	MOVEMENT 1 target IT is fixed 2 target IT moves at random 3 target IT moves according to a time and checkpoint plan
ISTAY(IP,IZ) ITMOV(IP,IZ)	NTAR	17ST(1T) 1TSTOP(1T)	10ET(1T) .	IMV(IT)

TARGET INPUTS (Continued)

Movement (Cont'd.)

For IMV = 2 or 3 supply =

Fraction of the time target IT is moving during the day FRCMVD(IT)

FRCMVN(IT)

RANMAX(IT)

TVEL (IT)

Fraction of the time target IT is moving during the night

Velocity of the ITth target. (O if not a manned target) - meters/sec. Maximum range target IT can travel. (Random only) - meters

IF IMV = 3 also add

(TI)dwil

Number of movement periods for target IT.

The time that target IT initiates movement - days, hrs, min, sec. period IL. ITIMS(IL, IT)

The X coordinate of the goal point for movement period IL of target IT. GCALTX(IL,IT)

The Y coordinate of the goal point for movement period IL of target IT. GOALTY (IL, IT)

coordinates

4-digit military

The X starting coordinate for the ITth target (0 if random).

TC(1,1T)

TC(2,1T)

The Y starting coordinate for the ITth target (0 if random).

coordinates

4-digit military

Table 3-1, Mamelist Inputs (Sheet 9)

CHARACTERISTICS

TARGET INPUTS (Continued)

							u	
- meters					89	•	to to	1 formation
The average width of an element of target IT.	The number of fire teams making up target IT.	The number of elements making up target IT.	The average visual reflectivity of an element of target IT.	The average 1.06 micron reflectivity of an element of target IT (for laser designation).	The hearing threshold for a member of target IT.	FORMATION	0 if a vegetation class dependent formatic is to be used 1 if a specific formation for target IT is be used (e.g., a fixed set of buildings)	The locations within a target for a special formation of each of the J elements for target IT
TC(4,IT)	TC(5,1T)	1C(6,1T)	TC(7,IT)	TC(8, 1T)	TC(9,1T		IFT(IT)	FORMT(1,J,IT)
	The average width of an element of target IT.	The average width of an element of target IT. The number of fire teams making up target IT.	The average width of an element of target IT. The number of fire teams making up target IT. The number of elements making up target IT.	The average width of an element of target IT. The number of fire teams making up target IT. The number of elements making up target IT. The average visual reflectivity of an element of target IT.	The average width of an element of target IT. The number of fire teams making up target IT. The average visual reflectivity of an element of target IT. The average 1.06 micron reflectivity of an element of target IT.	The average width of an element of target IT. The number of fire teams making up target IT. The average visual reflectivity of an element of target IT. The average 1.06 micron reflectivity of an element of target IT. The average 1.05 micron reflectivity of an element of target IT (for laser designation).	The average width of an element of target IT. The number of fire teams making up target IT. The average visual reflectivity of an element of target IT. The average 1.06 micron reflectivity of an element of target IT. The average 1.05 micron reflectivity of an element of target IT. The hearing threshold for a member of target IT.	The average width of an element of target IT. The number of fire teams making up target IT. The average visual reflectivity of an element of target IT. The average 1.06 micron reflectivity of an element of target IT (for laser designation). The hearing threshold for a member of target IT. The hearing threshold for a member of is to be used O if a vegetation class dependent formation is to be used I if a specific formation for target IT is the used (e.g., a fixed set of buildings)

Table 3-1, Namelist Inputs (Sheet 10)

tion (Cont'd)		20 Pag Re	
	Where: I = 1 is the X location of element J relative to the J = 1 element	ge 3-1 vised	
	<pre>1 = 2 is the Y location of element J relative to the J = 1 element</pre>	relative (See UETECT)	
	(only used if IFT(IT) = 1)	-00 per 1	
	SOUND TRACK	973	
NSTP(IT)	Number of special sound track periods of target IT		
ISSOFF(IK,IT)	The time when the IK th sound period stops operating for target IT	- days, hrs, min, sec.	
ISSON(IK,IT)	The time when the IF th sound period starts to operate for target IT	- days, hrs, min, sec.	
SOUNDT(IK,IT)	Sound level for IK th sound period for target IT.	8P -	

Table 3-1, .damelist Inputs (Sheet 11)

DETECTION

TARGET INPUTS (Continued)

- meters	- meters	
The range between a target IT and SIAF which describes the distance beyond which detailed detection computations are not desired.	The range between a target IT and SIAF that always requires detailed detection computations without first checking feasibility.	O if target IT is to be eliminated upon detection l if SIAF should proceed toward target IT in order to identify the target given that it cannot be identified at detection 2 if SIAF should call external fire support against target IT after advancing for identification 3 if SIAF should avoid target IT upon first detection of target IT. (See PDDS)
RCMAX(IT)	RCMIN(IT)	KREC(1T)

Table 3-1, Namelist Inputs (Sheet 12)

TARGET INPUTS (Continued)	Continued)	EXTERNAL FIRE SUPPORT (This Section For EFS Only Attack)
IFSUP(IT)	~~	O no external fire support available artillery support available
	∢I	Artillery
IFADJ(IT)	· ·	O if fire without adjustment I if fire with adjustment
ITACT(IT)	- N m i	<pre>1 if target digs in in-place 2 if target expands circularly (if IFADJ(IT) = 1) 3 if target moves to cover</pre>
	ပါ	Close Air Support
IAMG(IT)	-0	l if air/ground machine guns are used O if air/ground machine guns are not used
ICBOM(1T)	-0	l if cluster bombs are used O if CBU's are not used
1GBOM(1T)		l if general purpose bombs are used O if general purpose bombs are not used
IFAR(IT)	- °	l if folding fin A/C rockets are used n if FFAR's are not used

Table 3-1, Namelist Inputs (Sheet 13)

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TARGET INPUTS (Continued)

FMCB1 (1T)

If Using Cluster Bombs

- square	- square	5		posture		square meters	square meters
Lethal area of CBU bomblet versus first pass personnel posture	Lethal area of CBU bomblet versus second and subsequent pass personnel posture	Number of ordnance delivering passes, CBU	If lising General Purpose Bombs	Mean area effectiveness (GP) - personnel posture	If Using Rockets	Lethal area of rockets versus second and subsequent passes personnel posture	Lethal area of rockets versus second and subsequent passes personnel posture
FMCB1 (17)	FMCB2(1T)	NCB(IT)		FMGPB(IT)		FMA1(1T)	FMAZ(IT)

Personnel vulnerable area to MG projectiles. -Number of rounds of machine gun fire

If Using Machine Guns

NGF(IT) VAX(IT) square meters

Table 3-1, Namelist Inputs (Sheet 14)

WEATHER INFORMATION

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Time of sunrise	days, hrs. min. sec days, hrs. min. sec
Time at which weather class changes	days, hrs. min, sec
New weather class commencing at time NWCL(I,1)	1
Daily weather information	
I: Day of the patrol.	
J:] = time of moonrise	hrs, min
2 = time of moonset	hrs, min
3 = type of moon .	
Type 0 = New Moon	
Type 1 = 1/4 Moon	
Type 2 = 1/2 Moon	
Type 3 = Full moon	
4 = Maximum temperature	L .
5 = Minimum temperature	<u>u</u> .
6 - Maximum relative humidity	×
7 = Minimum relative humidity	×
8 = Minimum wind velocity	kts
9 = Average wind velocity	kts
<pre>10 = Maximum wind velocity</pre>	kts
<pre>11 - Direction wind is coming from</pre>	Compass bearing
	0 - 360

Table 3-1, Namelist Inputs (Sheet 15)

COMBAT INPUTS

3
E S

AMA	Mean human reaction time to detection	
SSIG	Standard deviation of human reaction itself	Seconds
UNKCON	Factor to compute area of uncertainty of target position as a	Seconds
VELNOM (I,K)	Nominal velocity, moving normally I = 1, or moving at top speed I = 2, where K = 1 for attackers	Meters/Seconde
FHCR	Fraction of height below which subject is said to be not standing	
XMAXDT	rraction of height below which subject is said to be prone. Elapsed time from last detection after which target position becomes unknown.	A Page 1
MAXDT	Maximum time after which previous detections lose their value	
DELTA	Increment by which firing allocations are varied in the point	Seconas
AIMMX (K)	Contains maximum aiming time: K = 1 *********************************	
FTAPB (K)	Contains fraction of time between bursts spent aiming; K - 1 defender attacker, K - 2 defender	Seconds
DTEFS	Maximum probable delay of EFS after EFS is called	Seconds
HFR	Height above terrain cutoff for firing	Seconds

Table 3-1, Namelist Inputs (Sheet 16)

Firing (Cont'd)

Meters

Table 3-1, Namelist Inputs (Sheet 17)

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The relative spacing in the Y direction of the patrol element from the fire team leader of fire team formation type J	The relative spacing in the X direction of the fire team in position from the leader of the maneuver unit in formation	The relative spacing in the Y direction of the fire team in position from the leader of the maneuver unit in formation type J	FIRING ALLOCATION	Contains minimum fraction of fire power directed against each detected target; K = 1 defender, K - 2 attacker	Contains weapon weighting factor for firing allocation	<pre>J = 1 - attacker applies to defender's weapons 2 - defender applies to attacker's weapons</pre>	<pre>I = 1 - simi-automatic weapon 2 - automatic weapon 3 - grenade launcher</pre>	Contains minimum length of each man's area of responsibility; K = 1 attacker, K - 2 defender	Contains fractional overlap of each man's area of responsibility; 1 attacker, 2 defender	Contains lateral distance on each side of right-most and left-most targets for defending total area of responsibility; K = 1 defender, K - 2 attacker
FORSFY(J)	FORSMX(J)	FORSMY (J)		COLMIN(K)	WPWT(I,J)			ARSMN(K)	ARSPI(K)	FDGFAC(K)

ί,

Formations (Cont'd)

Table 3-1, Namelist Inputs (Sheet 18)

DEPLOYMENT CRITERIA (See DLOGIC)

RAMB	Ambush range between deployment point and engagement point	F eters
RAMIN	Minimum admissible value of RA (see subroutine DLOG5)	Heters
RATT	Attack range between deployment point and engagement point	Me ters
REFS	Minimum admissible distance between the subject patrol and object patrol for calling EFS.	Meters
ROBS	Maximum admissible distance between the subject patrol and the engagement point to use detailed terrain information (See DLOG7)	et St
RSP	Approximate distance desired between trial deployment points	eters
RZ	Maximum admissible ratio of line-of-sight cut-off distance to range to observed target for adequate cover due to line-of-sight obstruction	
IOIREC	1 - SIAF to be the subject patrol2 - target to be the subject patrol	
IPURSU(J)	 o if the maneuver unit is not to pursue the defender in the withdrawal mode past the last attacker objective point (presently not used). 	
GSAPRR	Approximate spacing desired between rows and between columns of predeployment movement area array. (See DLOG8)	Heters
NSECT	Number of angular increments (through pi radians) subtended by the circular array of trial deployment points about a stationary object patrol	

Table 3-1, Namelist Inputs (Sheet 19)

Deployment Criteria (Cont'd)

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								Seconds	Seconds	Seconds	Seconds
Minimum admissible value of ADM, where ADM is the average merit value of trial points set in predeployment movement area (0 ≤ CADM ≤ 1). (See DLOGIC)	Minimum admissible force ratio for ambush	Minimum admissible force ratio for attack	Maximum admissible slope from deployment point to engagement	Percentage thresholds, to be used jointly, with PP1 , PP5, for determining adequate cover, concealment, and observation (see subroutine CCO).	O if micro-relief Class J and vegetation Class K are deemed jointly admissible for a deployment point (See DLOG7).	1 if micro-relief Class J and vegetation Class K are deemed joint conditionally admissible	2 if micro-relief Class J and vegetation Class K are deemed joint inadmissible	Minimum deployment time required for ambush	Minimum deployment time required for attack	Maximum admissible time for object patrol to move to engagement point	Maximum admissible time for subject patrol to move to deployment point.
САДМ	FRAMB	FRATT	GMAX	3 8 3	CLASS(J,K)			DTDAMB	DTDATT	DTENGM	DTPURM

Table 3-1, Hamelist Inputs (Sheet 20)

(Cont'd)	
Criteria	
Deployment	PP1

Probability thresholds, to be used jointly with CC2, CC3, for determining adequate cover, concealment and observation (see subroutine CCO).	Coefficients, non-negative and summing to 1, used to determine the merit value of a point in the movement area (See subroutine CCO).	FIRING OPTIONS (See FIREOP) Firing options for the base of fire where I - the average suppression state of the base of fire, J - the average suppression state of the unit they are supporting, and K - I for attackers, K - 2 for defenders.	Firing options for the unit being supported by the base of fire where J is the average suppression state of the unit and $K-1$ for attackers, $K-2$ for defenders	SUPPRESSION Defines suppression state J as a function of P _{HIT} per minute; K - 1 defender, K - 2 attacker (See SUPN)	Contains degradation factors J each suppression state (1); J - 1 firing rate; J - 2 aiming accuracy; J = 3 moving; J = 4 hand grenades	$\frac{\text{MITHDRAWAL}}{\text{Number of angular increments (through a half arc of } 60^0) \text{ between middle}}{\text{trial point and extreme trial point (use to select a rally point). (See RPT)}$
PP2 PP4 PP4	Q2 Q3 Q3	F0TB(1,J,K)	F0TM(J,K)	DSUST (J,K)	SUFAC(I,J)	NSECTR

Table 3-1, Namelist Inputs (Sheet 21)

7

Withdrawal (Cont'd)

Radius of circular array of trial points for withdrawing to

rally point

Maximum allowable value of the ratio:

CARFR

number of casualties carried number of members carrying

Maximum admissible ratio of current food per man to initial food for extraction

ü

প্ত

Maximum admissible ratio of current water per man to initial water per man for extraction

Minimum admissible number of days elapsed for extraction

LDAYS

DEFENDER REACTION (See Subroutine REACT)

Defender option index (after detecting attacker)
1 Withdraw at top speed
2 Deploy in place

KDEF0P

3 Start firing in place

4 Ignore detection

5 Rotate formation and stop

6 Deploy with stealth to new point

Table 3-1, Namelist Input: (Sheet 22)

ATTRIBUTES

Personnel attributes I for each man J, K = 1 for attackers K = IT + 1 for defenders, where IT is the target number 1-4

the attribute of the Patrol Member ţ

Team number

Weapon number (See WTS in Weapon Supply DATA BASE)

Current ammunition supply (rounds)
Casualty status: 0 = not a casualty

- minor wound

= major wound

= not firing = dead Firing status:

သ

= area fire

* point fire

(meters) Current suppression state Current X coordinate Current Y coordinate

(meters) me ters meters coordinate coordinate Next Next

meters) るらられ

(meters)

crouching 1 = standing Current posture:

Moving Status (0 = stopped, 1 = moving 3 * prone

Maneuver unit to which the element belongs normally, 2 = moving at top speed)

Number of rounds remaining in m≓gazine Function in Patrol:1 * Patrol Leader

16

- Asst. Patro Leader

 Grenade Launcher - Machine Gunner

Movement rate of each individual - Rifleman 28

Table 3-1, Namelist Inputs (Sheet 23)

XATT(1.3,K)

Attributes (Cont'd)

2 = if in maneuver unit Individual's assignment: 1 = if in base of fire 9

20 21

Initial ammunition supply Weapon type: 1 = point fire 2 = area fire

Position in fire team Secondary Weapon Carried: 13 = Hand Grenade 0 = None 23

Hand Grenade Supply Smoke Grenade Supply 24 25

for attackers, K = II + 1 for defenders, where IT is the target number 1-4 Maneuver unit attributes I for each maneuver unit J.

YATT(1,3,K)

I: 1 = Movement type, loads MOVTYP
2 = Number of fire teams in the maneuver unit

3 = Index M used to specify which of the particular permutation used to assign fire teams to their positions within their maneuver unit

Number of patrol member acting as leader of 5 = Manuever Unit assignent, Loads IBF the maneuver unit. Loads KPEN

l = base of fire
0 = moving

Table 3-1, Namelist Inputs (Sheet 24)

ATTRIBUTES (LON INC 4)

Attacker defender attribute 1, K = 1 for SIME, E for target IT, where IT is the target number 1-4

ZATT(1,K)

1 - Number of maneuver units in the patrol

2 = Patrol mission. Loads MISS
3 = Availability of external fire support to patrol;

0 = not available

4 = Patrol member number of patrol leader. Loads NPL 5 = Patrol member number of assistant patrol leader. | = available. Loads EFSA

Loads NAPL

patrol. Loads SCEMI(1) Relative weight factor assigned to semi-automatic Relative weight factor assigned to semi-automatic weapons in defining firepower for the attacking # **9**

weapons in defining firepower for the defending patrol. Loads CSEMI(2)

weapons in defining firepower for the attacking patrol. Loads CAUTO(1) Relative weight factor assigned to automatic Relative weight factor assigned to automatic œ

weapons in defining firepower for the defending patrol. Loads CAUTO(2)

Relative weight factor assigned to grenades in defining firepower for the attacking patrol. Loads CGREN(1)

2

Relative weight factor assigned to grenades in defining firepower for the defending patrol. Loads CGREN(2) _

break contact decision for defenders. Loads FPMAX(1) Firepower ratio which if exceeded will result in a 2

break contact decision for attackers. Loads FPMAX(2) Firepower ratio which if exceeded will result in a n 2

Table 3-1, Namelist Inputs (Sheet 25)

ATTRIBUTES (CONTINUED)

will result in a break contact decision Maximum number of rounds per man which 7

will result in a break contract decision Maximum number of rounds per man which for attacking patrol. Loads RLIM (1) 15

Casualty fraction which it exceeded will result in a break contact decision for for defending patrol. Loads RLIM (2) 9

Casualty fraction which if exceeded will Loads CFMAX(1). attacking patrol. 1

result in a break contact decision for Loads CFMAX(2). defending patrol. . 8

Value of the loss of key personnel (see defini-tion of L(K)) which will result in a break Value of the loss of key personnel (see defini contact decision for attackers. Load LKP(1) tion of L(K)) which will result in a break Ħ

6

Elapsed engagement time which will result in contact decision for defenders. . 20

Load LKP(2)

Elapsed engagement time which will result in a break contact decision for attacking Loads (TLIM(1) patrol. 2

Range between units which will result in a a break contact decision for defending Loads TLIM(2) patrol. Ħ 22

break by defending patrol. Loads DISTL Orientation angle of patrol configuration if stationary, as required by subroutine FORMST 23

Table 3-1, Namelist Inputs (Sheet 26)

WEAPON

Contains lethal areas for grenade Type J

XLAAW(I,J)

I = 1 Lethal area for minor wound - target position I = standing

Lethal area for minor wound - target position 2 = crouching

Lethal area for minor wound - target position 3 = prone

Lethal area for major wound - target position 1 = standing

5 Lethal area for major wound - target position 2 = crouching

6 Lethal area for major wound - target position 3 = prone

Lethal area for death wound - target position 1 = standing

8 Lethal area for death wound - target position 2 = crouching

9 Lethal area for death wound - target position 3 = prone

Table 3-1, Mamelist Inputs (Sheet 27)

WEAPONS (Continued)

Weapon characteristics I for each weapon number J.

WCHAR(I,J)

```
Minimum number of aimpoints in area of responsibility
                                                                                                                                                                                                                                                                                                                                                         Maximum number of aimpoints in area of responsibility
                                                         Actual firing rate - point fire (trigger pulls/min)
                                                                                                                                                                                                                                                                                                                                                                                                                                         ertical aimpoint above ground level for area fire
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | = semi-automatic, 2 = automatic, 3 = grenades)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Weapon type for firing allocating weight factors (1 = semi-automatic, 2 = automatic, 3 = grenades
                                                                                                 Actual firing rate-area fire (trigger pulls/min)
                                                                                                                                                                                                                                                                                                                                      Distance between aimpoints - area fire (meters)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ethal area indicator (= 0 except for grenades)
                                                                                                                                                               used if aim error indicator
                                       Rounds per trigger pull - point fire
                                                                                Rounds per trigger pull - area fire
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Weapon magazine capacity (rounds)
                                                                                                                       P given hit indicator (or value)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Weapon type for area assignment
                                                                                                                                                                                          is zero
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Loading time (Seconds)
(meters)
                     (meters)
                                                                                                                                              Air error indicator
Maximum range
                     Minimum range
                                                                                                                                                               (mils)
                                                                                                                                                                                       mils)
                                                                                                                                                                                                          mils)
                                                                                                                                                                                                                                mils)
                                                                                                                                                                                                                                                     (mils)
                                                                                                                                                                                                                                                                       mils)
                                                                                                                                                                                                                                                                                           mils)
                                                                                                                                                                                                                                                                                                                 (mils)
                                                                                                                                                                                                                                                                                                                                                                                                                        - area fire
                                                                                                                                                                                                                                                                                                                                                                                  - area fire
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 meters)
                                                                                                                                                                                                                                a Y2
                                                                                                                                                                                                                                                                                           g X3
                                                                                                                                                                   ۵X
                                                                                                                                                                                       ٩١١
                                                                                                                                                                                                                                                                                                                                                                                                                                            20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   23
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      2
```

Table 3-1, Namelist Inputs (Sheet 28)

MINES

Number of mines deployed by Subject Patrol	= Length of mine field (meters)	 Coordinates of the centroid of the mine field deployment line segment. (line along which mines are deployed). (Map Coordinates) 	 Angle that the mine field deployment lines makes with the X-axis. Positive counterclockwise 	= Lethal area for mines. See table XLAAW, Volume IV	 Lethal area indication for mines. Points to appropriate lethal area column for mines in table XLAAW 	Coordinates of engagement point (Map Coordinates)	EXTERNAL FIRE SUPPORT (For Combat Model)	 The time to make a request for EFS plus aiming calculation time, and time for flight of the shells 	 The time to communicate open fire request plus the time of the flight of the shells given that attack has been previously planned 	 The time delay between each volley of shells 	The safe-distance radius between the SIAF and target for an
	гбтн	XCENT YCENT		XLAAW (I,LAIC)	LAIC	XENGA YENGA					SAFDIS

Table 3-1, Namelist Inputs (Sheet 29)

External Fire Support (Cont'd)

1,

the standard deviation.	Variable whose value (1, 2, 3, 4, 5, 6) specifies which type of artillery or air support	is used:	2 = 155 MM Howitzer	3 = 105 MM Howitzer	4 = 1/2 mm GUN 5 = 8 inch Howitzer	6 = Air support
	H					
	JARTL					•

_
level J
Lethal radius of selected ammo against Posture (Z) for kill level J*l death, J*2 major wound, J*3 minor wound.
Z) fo
sture (7 nd.
inst Po: nor woul
mmo aga J≖3 mii
ected a
of sel 2 major
radius ith, J=
Lethal J*l de
(z,3)
AEE (Z,J

of O
completion
after
patrol
enemy
\$
ession state assigned to enemy patrol after comp irst volley of EFS
state olley
Suppression state a the first volley of
N

NSUPP

Default		0.1	10.
Units	res in set	meters	me ters
Definition	Total number of different personnel postures in set	Minimum segment length for which a segment is considered negligibly small	The maximum step size to be used in a mini-segment. The highest velocity moving feasible target will define the time step size to use for detailed
Symbol	IPOS	SEGMIN	DSTEP

Table 3-1, Namelist Inputs (Sheet 30)

(Cont'd)
ಕ್ಷಿ
Set
Base
Data

Default Value				Re te rs				20.	0.0735	See Subroutine HUMAN
Units		Heters	issance Only)	ch of the ation IFS an detection is	nt J	nt J		square ft	BTU/16 ⁰ F	me te rs
Definition	detection to assume, at most, a step size of DSTEP for any target or for SIAF (the value must be > 0)	Maximum distance patrol can move in any event time	FORMATION (Reconnaissance Only)	The location within a SIAF patrol for each of the elements J for each type of special formation IFS (used by Subroutine DETECT when man-to-man detection is desired)	where: I = 1 is the X location of element J relative to the J = 1 element	<pre>I - 2 is the Y location of element J relative to the J = 1 element</pre>	HUMAN MAINTERANCE	Body surface area	Convective capacity content	<pre>Energy expenditure rate for type L check point (rest, recon, sleep, etc subroutine HUMAN)</pre>
Symbol		MAXDIS		FORMS(I,J,IFS)				BSAREA	CONCAP	CPRAT (L)

Table 3-1, Namelist Inputs (Sheet 31)

Human Maintenance (Cont'd)

SIGFFR	Heat transfer constant: o* F * f where	BTU/ft ² hr (⁶ R) ⁴	0.1103 x 10 ⁸
	<pre></pre>	•	
RHOH	Air density	lbs/cu ft	0 036
a	Barometric pressure	Han Ha	260
70	Base film temperature, absolute	,	
Po	Standard pressure	Ha Ha	. 026 760
RPE	Vapor resistance, air	in. of air	
RPG	Vapor resistance, garments	in. of air	7 0 20
XMMAX	Maximum SIAF personnel energy expenditure rate(BTU/hr)	rate(BTU/hr)	

Table 3-1, Namelist Inputs (Sheet 32)

HUMAN MAINTENANCE (cont.)

vi sed	Decembe	r 19	73							
Default Value	See Subroutine LOGIS	1080.	.96	42.		5 x 10 ⁴	0.05	See Subroutine MICROT	See Subroutine VEGCO.	See NAMEL IST
Units	BTU/hr	BTU/16	<u>u.</u>	in. Hg				number/acre	number/acre	meters
Definition	Food consumption energy expenditure rate for type L checkpoint (rest, recon, sleep, etc see Subroutine HUMAN).	Heat of vaporization	Skin temperature	Vapor Pressure at skin	TERRAIN	Limiting value on terrain surface quadratic coefficient - a value close to zero indicates the terrain surface is approximately linear	Limiting value of slope differences	Density of micro-relief feature of type K (positive undulations, negative undulations, boulders) in micro-relief class I (I=1,,5).		Range at which a target has unity probability of being completely concealed by vegetation features of type U in class II.
Symbol	FWRAT(L)	LAMDAE	STS	PS		135	SL2	DMT (1, K)	RHOI(11,U)	RMAX(11,U)

Table 3-1, Namelist Inputs (Sheet 33)

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Strong of the control of the cont

meters

meters

Water depth in vegetation class 16

rice field

Table 3-1, Namelist Inputs (Sheet 34)

ĺ,

TERRAIN (Cont.)

Definition

Range at which a target has unity probability of being completely concealed by micro-relief features of type L (1=

RMTMAX(I,L)

Symbol

See Subroutine MICROT

Default Value

Units

meters

positive undulations, 2=negative undu-lations, 3-boulders) in micrc-relief class I (see Subroutine MICROT).

Width of vegetation features of type U (1-grass, 2-brush, 3-tree trunks,

See Subroutine VEGCON

meters

See Subroutine MITFEA

meters

4=tree crowns) in vegetation class I (see Subroutine VEGCON).

Width of micro-relief feature of type

K (1=positive undulations, 2=negative

undulations, 3-boulders) in micro-relief class L (see Subroutine MICROT)

Water depth in vegetation class 13

0.

meters

0.

meters

Water depth in vegetation class 14

dense swamp.

sparse swamp.

DSW11

DSW12

DRICE

H(1,U)

Height above surface of vegetation features (1=grass, 2=brush, 3=tree trunks, 4=crowns of trees) for

vegetation class I (I=1,...,16).

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TERRAIN (cont.)

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levi se	d Dece									
Default Value	See Subroutine TERCON	See Subroutine MICROT	7200.	2400.		See Subroutine VISUAL		See Light Penetration Subroutine (Volume II. Section 3.2)	See DETECT	See DETECT
Units	meters	meters	meters	meters					meters	meters
Definition	Height of obstacle of type J for J= l9 (see Subroutine TERCON).	Height of a micro-relief feature of type K (positive undulations, negative undulations, boulders) in micro-relief class I (I=1,,5).	The maximum X coordinate at the boundary of the area of operations.	The maximum Y coordinate at the boundary of the area of operations.	The effective background reflectance for vegetation class II where	l is with a downward look angle 2 is with a nearly parallel look	angle 3 is with an upward look angle	The fractional light penetration of vegetation class ll	The formation type for moving in the vegetation class II (1-file; 2-column; 3-diamond) (Reconnaissance Only)	The formation spacing parameter for the vegetation class II (Reconnaissance Only)
Symbol	нв(л)	HMT(1,K)	Архнах	АДУМАХ	REF(11, J)			XLP(11)	VEGC(3,11)	VEGC(1,11)

Table 3-1, Namelist Inputs (Sheet 35)

Subroutine)	
(See NAV	
NAVIGAT 10N	

ξ,

Default Value		200.	13.	300.
Units	meters	meters	me ters	meters
<u>Definition</u>	Sigma, Map Terrain Association, Best. For the area of SIAF operation this value represents the standard deviation of the best (minimum) distances within which SIAF can determine its location at any point on its route (except a check-point) by Map Terrain Association, provided that visibility and light level are adequate (i.e., ALLB, VISM = VISMB).	Sigma, Map Terrain Association, Worst, Anologous to SGMTAB, but for poor visibility (VISM = VISMW, ALL = ALLW). This term represents the limit on position location by map terrain association.	Meteorological Visibility, Best. Visibility (VISM) at which the surrounding terrain features can be seen and identified in sufficient detail to allow the SIAF location to be determined (by Map Terrain Association) to approximately the distance given by the one sigma value of SGMTAB.	Meteorological Visibility, Worst. Similar to VISMB described above, but for the "worst" visibility. If VISM = VISMW then SGMTA = SGMTAW. If VISM < VISMW then SIAF location cannot be determined by Map Terrain Association.
Symbol	SGMTAB	SGMTAW	V I SMB	N I SMM

Table 3-1, Namelist Inputs (Sheet 36)

NAVIGATION (cont.)

Default Value	4 × 10 ³	900.	. 10g	25.	25.	₹
Units	ft lamberts	seconds	ft lamberts	me te rs	me te rs	
Definition	The "worst" value of Ambient Light Level (ALL) for Map Terrain Associ- ation. If ALL > ALLW then SIAF location cannot be determined by Map Terrain Association.	Average time necessary to get an air craft on-site if PPLS is to be used	The "best" value of Ambient Light Level (ALL) for map-terrain-association (i.e., that value of ALL at which SIAF location can be determined to approximately SGMTAB provided that visibility is good). If ALL > ALLB then it is assumed that ALL > ALLB.	Point-on-map Error (Constant Component). Error assicated with putting the believed SIAF location on the map as a point (25 meters suggested for 1:50,000 map; other map scales are automatically converted internally).	Point-on-map Error (component that in- creases with range traveled). (25 meters for 1:50,000 map; other values converted internally).	Range Error Constant. Average error associated with estimating range traveled (by pace count), expressed as % of distance traveled since last check-point.
Symbol	ALLW	ITAC0S	ALLB	PAC	AA.	SC SC SC SC SC SC SC SC SC SC SC SC SC S

Table 3-1, Namelist Inputs (Sheet 37)

NAVIGATION (cont.)

Default Value 10.	25.	1.85	0.	*	25.	0.
Units	meters	degrees	degrees	degrees	meters	degrees
Range Error Constant Target Estimate. Average error (°) associated with visual estimation of the range to a sighted target, expressed as % of estimated	Base Error. (ogg). Average distance between SIAF 10cation and exact center of checkpoint location when SIAF believes it is at checkpoint.	Average compass reading error (assume more than one compass reading is taken for mission leg).	Effect of special equipment on esti- mating average compass reading error.	Angle error, target estimate. Average compass reading error of bearing to target.	Grid Reading Error. Introduced by translating the point on the map into eight-digit grid readings (25 meters for 1:50.000 map; other values converted).	Effect of terrain on estimating average compass reading error.
Symbol RCT AR	39	AA	AEQ	ATTAR	SR.	ATER

Table 3-1, Namelist Inputs (Sheet 38)

NAVIGATION (cont).

evised	l Decen	nber 19	973					pu c	RATE
Default Value	°.	.0	.09	120.	œ.	120.	.006	.3 meters per second	See Subroutine MVRATE
Units			seconds	seconds	seconds	seconds	seconds	ine MVRATE)	km/hr
Definition	Effect of terrain on estimating range traveled.	Effect of special equipment on estimating range traveled.	Average time for SIAF to determine its position by dead reckoning, put point on map, and read eight digit grid coordinates.	Average time necessary to attempt position location by map-terrain association with good light and visibility, given general area by dead reckoning.	Average time necessary to estimate range and bearing of target visually detected.	Average time for an accurate (CEP = 50 meters) navigational fix by PPLS once A/C is on site.	Average time for a "quick" navigational fix (CEP = 150 meters) by PPLS once A/C is on site.	Typical SIAF movement rate. (See Subroutine MVRATE)	Movement rates for night (J=1) and day (J=2) over te.rain slopes satisfying for various slope values I
Symbol	RTER	REQ	ITORPM	ITMMTA	ITNTAR	ITPLSA	ITPLSQ	VTYP	TMR(1,J)

Table 3-1, Namelist Inputs (Sheet 39)

MOVEMENT RATE (Cont'd)

Sombol Definition Units Default Value		MVRATE	HVRATE	MVRATE	MVRATE	4VRATE	rage 3-4 Revised
Slope limits definition Slope limits defining movement rate as a step function Movement rate degradation factor for vegetation class I (I = 1,,16). Movement rate degradation factor for soil type J (see Subroutine SOIL), for wet conditions (I=2). Night and day limits of ambient light level for a movement rate degradation (lower limit I=1, upper limit I=2, night J=1, upper limit I=2, night J=1, day J=2). Movement rate degradation factor for night (J=1) and day (J=2) for various values (I=1,2,3; see Subroutine MVRATE) of ambient light level. The speed adjustment factor for the vegetation class II (integer).	Default Value	See Subroutine	See Subroutine	See Subroutine	See Subroutine	See Subroutine A	See MOVET
	Units				ft lamberts		
Symbol TMR(1,3) VEGF(1) SOILF(1,J) ALIM(1,J) ALLF(1,J)	<u>Definition</u>	Slope limits defining movement rate as a step function	Movement rate degradation factor for vegetation class I (I = 1,,16).	Movement rate degradation factor for soil type J (see Subroutine SOIL), for wet conditions (I=1) and dry conditions (I=2).	Night and day limits of ambient light level for a movement rate degradation (lower limit I=1, upper limit I=2, night J=1, day J=2).	Movement rate degradation factor for night (J=1) and day (J=2) for various values (I=1,2,3; see Subroutine MYRATE) of ambient light	The speed adjustment factor for the vegetation class II (integer). (Used by target Only)
	Symbol	TMR(1,3)	VEGF(I)	S01LF(1,J)	ALIM(I,J)	ALLF(1,J)	VEGC(2,11)

Table 3-1, Namelist Inputs (Sheet 40)

Movement Rate (Cont'd)

						AURAL	AURAL	AURAL	AURAL	AURAL	AURAL	
					Default Value	See Subroutine AURAL	See Subroutine AURAL	See Subroutine AURAL	See Subroutine	See Subroutine AURAL	See Subroutine AURAL	
					ឧ		See	See	See	See	See	
on for	on for	L	L		Units	dB/meter	8 9	8 P	8	g p	dB/kno€	41)
Weighting factor associated with detection for critical movement problem	Weighting factor associated with detection for marginal movement problem	Weighting factor associated with time for critical movement problem	Weighting factor associated with time for marginal movement problem	AURAL DETECTION	Definition	The attenuation coefficient for sound passing through solid growth of feature type J. This will be modified by growth density in the subroutine (1=grass, (2=brush, 3=tree trunk, 4=tree crown).	The background noise level for vege- tation class II in the daytime.	The background noise for vegetation class II in the nighttime.	The noise generated by one man moving in vegetation class II.	The noise generated by one man not MOVING IN VEGETATION class II.	The incremental wind background noise for vegetation class II.	Table 3-1 damplic+ front (Choo+ 41)
MDC		WTC	MIN		Symbol	ATTEN(J)	VEGC(4,II)	VEGC(5,11)	VEGC(6,11)	VEGC(7,11)	VEGC(8,II)	

Table 3-1, Namelist Inputs (Sheet 41)

DETECTION (See Subroutine DETECT)

Default Value	12.	÷	.09		0.5	See DETECT	See DETECT
Units	minutes of arc		meters	seconds			
<u>Definition</u>	Angular subtense required for identi- fication of a target	Contrast ratio required for recogni- tion of a target.	Distance behind target considered for background calculations.	Time interval in which detections can be considered simultaneous.	Fractional target width required to be visible for target recognition.	Sector of scan for the case of both patrols moving or both patrols stopped, where I=1 for the angular left bound for the sector of responsibility for the current sector index IND (IND=1,2,3,4), and I=2 is the angular right bound.	Sector of scan for the case of stationary observer and moving target where I and IND are as above. This variable is an adjustment to the scan sector due to peripheral vision being able to pick up targets at a much wider angle from forward than is nominal for a fixed target (see Subroutine DETECT).
Symbol	ANGID	CRECOG	DBACK	TDMIN	W.R.	SECT (I,IND,1)	SECT (I,1ND,2)

Table 3-1, Namelist Inputs (Sheet 42)

	DETECTION (See	DETECTION (See Subroutine DETECT)	
Symbol	Definition	Units	Default Value
ANGID	Angular subtense required for identi- fication of a target	minutes of arc	12.
CRECOG	Contrast ratio required for recognition of a target.		.
DBACK	Distance behind target considered for background calculations.	meters	50.
TOMIN	Time interval in which detections can be considered simultaneous.	seconds	
W.R.	Fractional target width required to be visible for target recognition.		0.5
SECT (I,IND,1)	Sector of scan for the case of both patrols moving or both patrols stopped, where I* for the angular left bound for the sector of responsibility for the current sector index IND (IND=1,2,3,4), and I=2 is the angular right bound.		See DETECT
SECT (1,1MD,2)	Sector of scan for the case of stationary observer and moving target where I and IND are as above. This variable is an adjustment to the scan sector due to peripheral vision being able to pick up targets at a much		See DETECT

Table 3-1, Namelist Inputs (Sheet 42)

wider angle from forward than is nominal for a fixed target (see Subroutine DETECT).

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ij
Detection

Symbol	Definition	Units	Default Value
ISECT(J)	Sector of primary surveillance responsibility for member J of a patrol (forward sectoral, left side=2, right side=3, rear sect-r=4).		1, 2, 3, 4, 1, 2
	MEATHER		
IDTIM	Time interval preceeding current time during which rain is considered to cause a current wet soil condition	hours	1.0
VISLUM(I,1)	Meteorological visibility at sea level for weather class I (see Subroutine WETHR).	meters	See Subroutine WETHR
VISLUM(I,J)	Illumination of the sky for weather class I, where J=2 for daylight; J=3 for sunrise; 4: sunset; 5: night, no moon; 6: night, quarter moon: 7: night, half moon; 8: night, full moon.	ft lamberts	See Subroutine WETHER

Table 3-1, Namelist Inputs (Sheet 43)

SUPPLY

AMWTAB(K)

K WEAPON 1. M-14(SA6)		
1. M-14(SA6		
	(9)	080.
2. M-14A1		080
3. M-60MG		080.
4. M-16(SA)		040.
5. M-16(A)		040.
6. Stoner MG	2	040.
7. M-79 GL		009.
8. XM-148 RGL	RGL	009.
9. AK-47		070.
101 AK-47(A)		070.
11. RPD Lt. MG	MG	070.
12. SGM Hvy. MG	. F.	070.
13. M26 A1		1.0
14. M18 A1		3.5
15. Stoner MG 1:14	MG 1:14	040
16. AAI SPIW(SA)	W(SA)	.029
17. AAISPIW(A)	(A)	.029
18. AAI SPIW MG	Z ZG	.033
19. 17. with	17. with 11.2 Gr Flechette	200.
20. 0.17 Cal(A)	I(A)	.037

Table 3-1, Namelist Inputs (Sheet 44)

FOOD SUPPLY

Total weight of patrol equipment carried pounds	Initial weight of equipment carried per man pounds	Initial amount of water carried per man bounds		per man		WEAPON SUPPLY	Number of rounds of ammo carried by SIAF for weapon type K.	Total number of resupply ammo rounds for weapon type K.	mines.	es carried by SIAF	hand grenades.	Total number of hand grenades carried by SIAF	on types	
PEQUIP Total weight of patro	EQUIP Initial weight of equ	H20 Initial amount of wat	RH20 Total weight of resupply water	FOOD Initial amount of food carried per man	RFOOD Total weight of resupply food		SAMU(K) Number of rounds of a weapon type K.	RAMU(K) Total number of resup weapon type K.	RMINES Number of resupply mines.	NMINES Total number of mines carried by SIAF	RHANDG Number of resupply hand grenades.	NHA4DG Total number of hand i	NSWT Number of SIAF weapon types	

Table 3-1, Namelist Inputs (Sheet 45)

1 - M-14(SA6)

2 - M-14A1

3 - M-60MG

4 - M-16(SA)

5 - M-16(A)

6 - Stoner MG 7 - M-79 GL

8 - XM-148 RGL

10 - AK-47(A) 9 - AK-47

11 - RPD Lt. MG

12 - SGM Hvy. MG 13 - M26 A1

14 - M18 A1

15 - Stoner MG 1:14

16 - AAI SPIW(SA)

18 - AAI SPIW MG 17 - AAISPIW(A)

19 - 17. with 11.2 Gr Flechette 20 - 0.17 Cal(A) Table 3-1, Namelist Inputs (Sheet 46)

COMPIUNICATION

minutes d8	hours	' }	sdue	dB Kilocycles	
Average external communication message duration Sound level increase during attempt of external communication	Length of communications period Transmitter frequency of the patrol radio	Transmitter output power Transmission power requirements	Reception power requirements Receiver noise figure	Receiver bandwidth Battery life for single radio (assuming a 9:1	Number of batteries carried per radio. Total number of radios carried by SIAF
TUSE XDBINS	ICPER FREQ	PT TPOWR	RPOWR RNF	BETA BLIFE	NBAT NRAD

Table 3-1, Namelist Inputs (Sheet 47)

DYNAMIC ROUTE (See Subroutine DROUTE)

	me te rs			are te rx			meters	meters
0 if point A.E.C.D. or E is to be deleted 1 if point A.B.C.D. or E is not deleted	Radial distance from XAVOID, YAVOID with which all grid points are to be deleted (enter 0 if no such position).	X coordinate of position for deletion of grid points	Y coordinate of position for deletion of grid points	Radial distance from XAVODD, YAVODD within which all grid points are to be deleted (enter 0 if no such position - second position).	X coordinate of second position for deletion of grid points	Y coordinate of second position for deletion of grid points	Approximate desired grid points spacing	Approximate desired spacing for second stage grid (LFLOBJ = 1, 1.GRID = 1)
10ELA 10ELB 10ELC 10ELC 10ELD	RAVOID	XAVOID	YAVOID	RAVODD	XAVODD	YAVODD	GSAPRX	GSAPXX

Table 3-1, Namelist Inputs (Sheet 48)

Dynamic Route (Cont'd)

First significant range from enemy position XPPI, YPPI; enter only if DYWI (9.MI) ≠ 0	First significant range from position XPPTT, YPPTT; enter only if DYWT (8,MI) $\not=$ 0	Second significant range from enemy position XPPT, YPPT, enter only if DYWT (9.MI) $\not\in$ 0	Second significant range from position XPPTT, YPPTT; enter only if DYWT (8,MI) ≠ 0	Risk factor associated with DSAA.	Risk factor associated with DMOR	Risk or benefit factor associated with DMORR	Risk factor associated with DSA	Number of parameters considered in the determination of path utility	Weight Factors for Assumed Missions; relative importance of parameter IPAR
DSA	DSAA	DMOR	DMORR	RFSAA	RFMOR	RFMORR	RFSA	NPAR	DYWT(IPAR,MI)

MI: Mission Situation

- " " Reconnaissance detect and identify suspected enemy but avoid encounter
- 2 * Reconnaissance avoid enemy and proceed as fast as possible
- 3 = Combat avoid detection and identification by the enemy

Table 3-1, Namelist Inputs (Sheet 49)

Dynamic Route (Cont'd)

IPAR:

1 = Movement Time

- SIAF Detects Enemy

= SIAF identifies enemy

Enemy detects SIAF

- Enemy identifies SIAF

6 = SIAF cover

 $8 = \text{Distance from Enemy } (2)^{\pm\pm}$

7 - SIAF Concealment

9 = Distance from Enemy (1)**

** The enemy locations can be used; however, the ninth parameter calculation refers to the same enemy position as the calculation of detection, identification, cover, and concealment.

CBDYNT (IPAR,ICB) The weight associated with parameter IPAR while movement type ICB

is in progress (Same definition as DYWT above; used for combat)

EXTERNAL FIRE SUPPORT (for EFS Only Mission)

	CALEMAN TIME SOLON (10) ETS ONLY MISSION	5
JNF	Total number of firings	
AIRC	1 - If FFAR's are helicopter launched0 - If FFAR's are fixed wing aircraft launched	
IPREP	O Don't use prep fire I Use LZ prep fire (prep fire assumed only on the primary LZ)	
PL	CBU bomblet pattern length meters	r
a.	CBU bomblet pattern width meters	ý
M. ANG.	Mean launch angle of MG firing	es
MLRANG	Mean launch range of MG firing	۶
LANGLE	Launch angle of FFAR salvo degrees	ses
LRANGE	Launch range of FFAR salvo	ý
MAE(i)	Lethal area of selected ammo versus square personnel in posture (i)	ên îv
F(1,j)	Fraction of personnel in posture (i) for each firing	
TBISTR	System delay time before first round or sec volley is delivered after fire request	
TBRNDS	System delay time between subsequent rounds/volleys	

Table 3-1, Namelist Inputs (Sheet 51)

EXTERNAL FIRE SUPPORT (cont.)

							meters	meters	meters	meters	meters	meters
				ass			for combat)			ised for combat)		
Number of rounds in each firing	Number of ordnance delivery passes, GP	Number of rockets launched - first pass	Number of rockets launched - second and subsequent passes	Number of CBU bomblets delivered, first pass	Number of CBU bomblets delivered, second and all subsequent passes	Number of GP bombs delivered	Artillery range probable error(also used for combat)	CBU delivery error - range	GP delivery error - range	Artillery deflection probable error(also used for combat)	CBU delivery error - deflection	GP delivery error - deflection
NN(J)	NROP	NRSIP	NRS2P	NCB 1 P	NCB2P	NGPB	RPA	RPECBU	RPEGPB	DPE	OPECBU	DPEGPB

Table 3-1, Namelist Inputs (Sheet 52)

Table 3.2, Alphabetical Cross Reference for Namelist Input Variables

Variable	Table 3.1 Sheet No.	Variable	Table 3.1 Sheet No.	Variable	Table 3.1 Sheet No.
AA	38	CONCAP	31	ENRNG	7
AEQ	38	CPRAT	31	EQUIP	45
AIMMX	16	CRECOG	42	F	51
AIRC	51	C1	22	FDGFAC	18
ALIM	40	C2	22	FHCR	16
ALLB	37	DBACK	42	FHPR	16
ALLF	40	DELTA	16	FMA1	14
ALLW	37	DF	17	FMA2	14
AMWTAB	44	DMOR	49	FMCB1	14
ANGID	42	DMORR	49	FMCB2	14
ARSMN	18	DMT	33	FMGPB	14
ARSPI	18	DOMMT	2	F00D	45
AOXMAX	35	DOMV	2	FORFTX	17
AO YMA X	35	DPE	52	FORFTY	17
ATER	38	DPECBU	52	FORMS	31
ATTAR	38	DPEGPB	52	FORMT	10
ATTEN	41	DRICE	34	FORMUX	17
BE	38	DSA	49	FORMUY	17
BETA	47	DSAA	49	FORSFX	17
BLIFE	47	DSTEP	30	FORSFY	18
BSAREA	31	DSUST	21	FORSMX	18
CADM	20	DSW1 1	34	FORSMY	18
CARFP	22	DSW12	34	FOTB	21
CBDYWT	50	DTDAMB	20	FOTM	21
CC1	20	DTDATT	20	FRAMB	20
CC2	20	DTEFS	16	FRATT	20
CC3	20	DTENGM	20	FRCMVD	9
CLASS	20	DTPURM	20	FRCMVN	9
COLMIN	18	DWDR	22	FREQ	47
COMRES	2	DYWT	49	FTAPB	16

Table 3.2, Alphabetical Cross Reference for Namelist Input Variables (cont.)

Variable	Table 3.1 Sheet No.	Variable	Table 3.1 Sheet No.	Variable	Table 3.1 Sheet No.
FWRAT	33	IFORMT	17	ITSTOP	8
GMA X	20	IFS	5	ITZERO	5
GOALTX	9	I FSUP	13	IXMAT	2
GOALTY	9	IFT	10	IXI	1
GR	38	I GBOM	13	IX2	1
GSAPRR	19	IMV	8	IYMAT	2
GSAPRX	48	IOB	3	JARTL	30
GSAPXX	48	IPERM	17	JNF	51
H	34	IPGS	30	JSTART	1
нв	35	IPREP	51	JSTOP	i
HFR	16	IPURSU	19	KDEFOP	22
HMT	35	ISECT	43	KREC	12
HLZ	7	ISEN	7	LAMDAE	33
H20	45	ISENLZ	7	LANGLE	51
IAMG	13	I SSOFF	11	LDAYS	22
ICBOM	13	ISSON	11	LGTH	29
ICL	3	ISTAY	8	LNRI	2
ICOMBF	1	ITACOS	37	LRANGE	51
ICPER	47	ITACT	13	MAE	51
IDELA	48	ITARIV	7	MAEE	30
IDELB	48	ITDRPM	39	MAXCAS	1
IDELC	48	ITIMS	9	MAXDIS	31
IDELD	48	ITMAX	6	MAXDT	16
IDELE	48	ITMOV	8	MAXREP	1
IDET	8	ITMATA	39	MICR1	3
IDTIM	43	ITNTAR	39	MLANGL	51
IDIREC	19	ITPLSA	39	MLRANG	51
IDOMST	2	ITPLSQ	39	MODE	6
IFADJ	13	ITRC	3	NBAT	47
IFAR	13	ITST	8	NBR	29
IFORFT	17	ITSTAY	7	NCB	14

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Table 3.2, Alphabetical Cross Reference for Namelist Input Variables (cont.)

				•	
Variable	Sheet 3.1 Sheet No.	Variable	Table 3.1 Sheet No.	Variable	Table 3.1 Sheet No.
NCB1P	52	NWCL	15	REF	35
NCB 2P	52	P	32	REFS	19
NCO	3	PEQUIP	45	REQ	39
NCOPY	1	PL	51	RESMAX	2
NDECOY	6	PMC	37	RFMOR	49
NFIX	8	PMR	37	RFMORR	49
NGF	14	PO	32	RFOOD	45
NGPB	52	PPLS	4	RFSA	49
NHANDG	45	PP1	21	RFSAA	49
NLZ	6	PP2	21	RHANDG	45
NMINES	45	PP3	21	RHOH	32
NMP	9	PP4	21	RHOI	33
NH	52	PP5	21	RH20	45
NOB	2	PS	33	RLZ	6
NPAR	48	PT .	47	RMAX	33
NPLAN	7	PW	51	RMINES	45
NRAD	47	Q1	21	RMTMAX	34
NRMT	2	Q2	21	RNF	47
NROP	52	Q3	21	ROBS	19
NRST	2	RAMB	19	RPA	52
NRS1P	52	RAMU	45	RPE	32
NRS2P	52	RAMIN	19	RPECBU	52
NRVP	2	RANMAX	9	RPEGPB	52
NSECT	19	RATT	19	RPG	32
NSECTR	21	RAVODD	48	RPOWR	47
NSENS	7	RAVOID	48	RSP	19
NSTP	11	RC	37	RTER	39
NSUPP	30	RCTAR	38	RZ	19
NSWT .	45	RCMAX	12	SAFDIS	29
NTAR	8	RCMI N	12	SAMU	45
NVOLLEY	30	RECRES	2	sc	5

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Table 3.2, Alphabetical Cross Reference for Namelist Input Variables (cont.)

Variable	Table 3.1 Sheet No.	Variable	Table 3.1 Sheet No.	Variable	Table 3.1 Sheet No.
SCALE	4	TO	32	XBASE	5
SECT	42	TI	29	XCENT	29
SEGMIN	30	T2	29	XDBINS	47
SGMTAB	36	Т3	29	XENGA	29
SGMTAW	36	UNKCON	16	XLAAW	27
SIGFFR	32	VAX	14	XLP	35
SIGMDIS	30	VEGC	35,40,41	XLZ	6
SL1	33	VEGF	40	XMAXDT	16
SL2	33	VEG1	2	XMMAX	32
SOILF	40	VELM	6	XMU	16
SOIL1	2	VELNOM	16	XOB	3
SOUNDT	11	VH	1	XPLAN	7
SPEC	4	ATSFR	43	YATT	24
SSIG	16	VISMB	36	YAVODD	48
STS	33	VISMW	36	YAVOID	48
SUFAC	21	VK	1	YBASE	5
TAK	29	VTYP	39	YCENT	29
TBRNDS	51	W	34	YENGA	29
TBUR	4	WCHAR	28	YLZ	6
TBISTR	51	WDAY	15	YOB	3
TC	9	WDC	41	YPLAN	7
TDEBK	6	WDM	41	ZATT	25
TDMIN	42	WMT	34		
THEATA	1	WPWT	18		
TMR	39	WR	42		
TPOWR	47	WTC	41		
TPREP	6	WTM	41		
TSR	15	WTS	45		
TSS	15	XATT	23		
TUSE	47	XAVODD	48		
TVEL	9	XAVOID	48		

4.0 MODEL OUTPUTS

4.1 RECONNAISSANCE MODEL OUTPUTS

The reconnaissance model output variables are defined in Table 4-1, and are listed according to the order in which they appear in the model output format. The method used to calculate these variables is described in subroutines SISTAT and SIWRT of Volume IV.

4.2 COMBAT MODEL OUTPUTS

The combat model output variables are defined in Table 4-2. In the model, these variables are printed out during each even time thus giving the user a time history of the events which took place during the combat operation.

Table 4-1, Model Output Variables (Sheet 1)

Symbol	Definition	Units
1VOR(11,1)	The number of visual detections of target IT by SIAF.	
SDETSR(11,1)	The visual detection success ratio of target IT by SIAF.	
SSTVOR(11.1)	The mean visual detection range of target IT by SIAF.	meters
SSSTVD(IT,1)	The standard deviation of the visual detection range of target IT by SIAF.	meters
SISTVD(IT.1)	Mean time of detection of target IT by SIAF.	days.hrs.min
SSISTV(11,1)	Standard deviation of the time of detection of target IT by SIAF.	days,hrs,min
1408(11)	Number of aural detection cues associated with the visual detection of target IT.	
11VOR(11,1)	Number of identifications of target IT by SIAF.	
S105R(11,1)	Identification success ratio of target IT by SIAF.	
SSTRR(IT,1)	Mean identification range of target IT by SIAF.	meters
SSSTRR(IT,1)	Standard deviation of the identification range of target IT by SIAF.	meters
SISTRT(IT,1)	Mean time of identification of target IT by SIAF	days,hrs,min
SSISTR(IT,1)	Standard deviation of the time of identification of target IT by SIAF.	days,hrs,min
IIAOR(IT,1)	Number of aural detections of target IT by SIAF.	

Table 4-1, Model Output Variables (Sheet 2)

Symbol	Definition	Units
SAURSR(IT,1)	Aural detection success ratio of target IT by SIAF.	
SSTADR(IT,1)	Mean aural detection range of target IT by SIAF.	meters
SSSTAD(IT,1)	Standard deviation of the aural detection range of target IT by SIAF.	meters
SISTAD(IT,1)	Mean time of an aural detection of target IT by SIAF.	days,hrs,min
SSISTA(IT,1)	Standard deviation of the time of an aural detection of target IT by SIAF.	days,hrs,min
SCEPTA(IT)	The mean target location CEP of target IT.	meters
SSCEPT (IT)	Standard deviation of the target location CEP of target IT.	meters
IVOR(IT,2)	The number of visual detections of SIAF by target IT.	
SDETSR(11,2)	Visual detection success ratio of SIAF by target IT.	
SSTVOR(IT,2)	Mean visual detection range of SIAF by target IT.	meters
SSSTVD(IT,2)	Standard deviation of the visual detection range of SIAF by target IT.	meters
SISTVD(IT,2)	Mean time of detection of SIAF by target IT.	days.hrs.min
SSISTV(IT,2)	Standard deviation of the time of detection of SIAF by target IT.	
11VOR(11,2)	Number of identifications of SIAF by target IT.	

Table 4-1, Model Output Variables (Sheet 3)

Symbol	Definition	Units
S105R(1T,2)	Identification success ratio of SIAF by target IT.	
SSTRR(IT,2)	Mean identification range of SIAF by target IT.	meters
SSSTRR(11,2)	Standard deviation of the identification range of SIAF by target IT.	meters
SISTRT(IT,2)	Mean time of identification of SIAF by target IT.	days,hrs,min
SSISTR(IT,2)	Standard deviation of the time of identification of SIAF by target IT.	days,hrs,min
11AOR (11,2)	Number of aural detections of SIAF by target IT.	
SAURSR (11,2)	Aural detection success ratio of SIAF by target IT.	
SSTADR(IT,2)	Mean aural detection range of SIAF by target IT.	meters
SSSTAD(IT,2)	Standard deviation of the aural detection range of SIAF by target IT.	meters
SISTAD(IT,2)	Mean time of an aural detection of SIAF by target IT.	days,hrs,min
SSISTA(IT,2)	Standard deviation of the time of an aural detection of SIAF by target IT.	days,hrs,min
SL05R(1T,1)	Percent of the time target IT is not detected by SIAF due to a relief intercept.	
SLOSV (11,1)	Percent of the time target IT is not detected by SIAF due to a vegetation intercept.	

Table 4-1, Model Output Variables (Sheet 4)

Units						km/hr	km/hr	days,hrs,min	days,hrs,min	Æ	K	
Definition Percent of the time target IT is not detected by SIAF	due to insufficient range or light. Percent of the time target IT is not detected by SIAF due to insufficient time.	Percent of the time SIAF is not detected by target IT due to a relief intercept.	Percent of the time SIAF is not detected by target IT due to a vegetation intercept.	Percent of the time SIAF is not detected by target IT due to insufficient range or light.	Percent of the time SIAF is not detected by target IT due to insufficient time.	Mean movement rate of the SIAF patrol.	Standard deviation of the movement rate of the SIAF patrol.	Mean patrol duration.	Standard deviation of the patrol duration.	Mean distance traveled by the SIAF patrol.	Standard deviation of the distance traveled by the SIAF patrol.	Patrol velocity histogram. This vector consists of 12 elements. In each element, the percent of time the patrol is moving is stored in increments of 0.2 of a kilometer per hour.
Symbol SLOSD (IT, 1)	SL0ST(1T,1)	SL0SR(1T,2)	SL.0SV (IT,2)	SL0SD(IT,2)	SL0ST(IT,2)	SMV EL	SSVEL	STIME	SSITIM	SPATDI	SSPATD	SVEL(I)

Table 4-1, Model Output Variables (Sheet 5)

The mean patrol location CFP at chacknown.	Units
Standard deviation of the patrol location CEP at checkpoints.	me ters
Mean time for the patrol to determine its location.	meters minutes
Standard deviation of the time for the patrol to determine its location.	Binutes
Mean number of communication attempts.	
Standard deviation of the number of communication attempts.	
Mean communication success ratio of the patrol. Standard deviation of the communication success ratio of the patrol.	
The percent of the communication power loss due to relief for communication failures.	
The percent of the communication power loss due to vegetation for communication failures.	
The percent of the communication power loss due to range for communication failures.	
The mean time the communication receiver of the patrol is on.	davs.hrs.min
Standard deviation of the time the communication receiver of the patrol is on.	dave hre min
The mean time the transmitter of the patrol communication equipment was on.	days,hrs,min

Table 4-1, Model Output Variables (Sheet 6)

Units	days, hrs.min	amo hrs	amo hrs	amp hrs	lbs/man	The /max	lbs/men	lbs/man	lbs/man	lbs/man	lbs/man	lbs/man
Definition	Standard deviation of the time the transmitter of the patrol communication equipment was on.	Ampere hours available at the beginning of the patrol.	Mean ampere hours used by the communication equipment during the patrol.	Standard deviation of the ampere hours used by the communication equipment during the patrol.	Amount of food carried per patrol member at the beginning of the mission.	Amount of water carried per patrol member at the beginning of the mission.	Amount of ammunition carried per patrol member at the beginning of the mission.	Amount of ordnance other than ammunition carried per patrol member at the beginning of the mission.	Mean amount of food carried by each patrol member at the end of the patrol.	Standard deviation of the amount of food carried by each patrol member at the end of the patrol.	Mean amount of water carried by each patrol member at the end of the patrol.	Standard deviation of the amount of water carried by each patrol member at the end of the patrol.
Symbol	SSTTUS	AMPHR	SAMPHR	SSAMPH	F000	HZ0	XP2	хРз	SF00DA	SSF000	SH20A	SSH20A

Table 4-1, Model Output Variables (Sheet 7)

Symbol	Definition	Units
SPAK2	Mean amount of ammunition carried by each patrol member at the end of the patrol.	lbs/men
SSPAK2	Standard deviation of the amount of ammunition carried by each patrol member at the end of the patrol.	lbs/man
SPAK3	Mean amount of ordnance other than ammunition carried by each patrol member at the end of the patrol.	lbs/man
SSPAK3	Standard deviation of amount of ordnance other than ammunition carried by each patrol member at the end of the patrol	lbs/man
SPDEGL	The mean human performance degradation at the end of the patrol.	
SSPOEG	Standard deviation of human performance degradation at the end of the patrol.	
SPOMAX	The mean of the maximum human performance degradation experienced by the patrol during the mission.	
SSPDMA	The standard deviation of the maximum human performance degradation experienced by the patrol during the mission.	
SPDMIN	The mean of the minimum human performance degradation experienced by the patrol during the mission.	
SSPDMI	The standard deviation of the minimum human performance degradation experienced by the patrol during the mission.	
SPDAVG	The mean of the average human performance degradation experienced by the patrol during the mission.	

Table 4-1, Model Output Variables (Sheet 8)

Symbol	Definition	Units
SSPDAV	The standard deviation of the average human performance degradation experienced by the patrol during the mission.	
SSIGEN	The mean of the energy expended per patrol member at the end of the patrol.	BTU
SSIGE	The standard deviation of energy expended per patrol member at the end of the patrol.	BTU
SSGMAX	The mean of the maximum energy expended per patrol member during the mission.	BTU
SSSGMA	The standard deviation of the maximum energy expended per patrol member during the mission.	BTU
SSGMIN	The mean of the minimum energy expended per patrol member during the mission.	вти
SSGMI	The standard deviation of the minimum energy expended per patrol member during the mission.	BTU
SSGAVG	The mean of the average energy expended per patrol member during the mission.	B TU
SSSGAV.	The standard deviation of the average energy expended per patrol member during the mission.	
PDPL01 (1)	A vector in which is stored a time history of human performance degradation for the mission.	

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Symbol	Definition	Units
HTPLOT(1)	A vector of times associated with the human performance values in PDPLOT.	
JJTIME(I)	A vector in which is stored the arrival time of SIAF at the checkpoints.	
AAALL (1)	The vector in which is stored a time history of the light level.	
KKTIME(I)	A vector of times associated with the light level data.	

Table 4-2, Combat Outputs (Sheet 1)

Units	•	•	rounds	•	•	•	meters	me ters	meters	meters	54 . 54	ine ters
Definition	Fire team number of man J ; $K = 1$ for attackers and $K = 2$ for defenders.	Weapon number of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Current ammunition supply of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Casualty status of man J; K = 1 for attackers and K = 2 for defenders. 0 = not a casualty; l = minor wound; 2 = major wound; 3 = dead.	Firing status of man J; $K = 1$ for attackers and $K = 2$ for defenders. $0 = not firing$; $1 = area fire$; $2 = point fire$.	Current suppression state of man J; $K=1$ for attackers and $K=2$ for defencers.	Current X coordinate of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Current Y coordinate of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Next X coordinate of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Next Y coordinate of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Height of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Width of man J; $K = 1$ for attackers and $K = 2$ for defenders
Symbol	ATT(1,J,K)	ATT(2,3,K)	ATT(3,J,K)	ΑΠ(4,3,Κ)	ATT(5,J,K)	ATT (6,3,K)	ATT(7,3,K)	ATT(8,J,K)	ATT (9, J, K)	ATT(10,3,K)	ATT(11, 3, K)	ATT(12,3,K)

Units	meters					meters/ seconds					nd K = 2 for	nders.	for defenders.
Definition	Current posture of man J ; $K = 1$ for attackers and $K = 2$ for defenders.	Moving status of man J; $K=1$ for attackers and $K=2$ for defenders. $0=$ stopped; $1=$ moving normally; $2=$ moving at top speed.	Maneuver unit of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Number of rounds remaining in magazine of the weapon of man J; $K=1$ for attackers and $K=2$ for defenders.	Function of man J in the patrol; K = 1 for attackers and K = 2 for defenders. l = patrol leader; 2 = assistant patrol leader; 3 = machine gunner; 4 = grenadier; 5 = rifleman.	Movement rate of man J; $K = 1$ for attackers and $K = 2$ for defenders.	Man J's maneuver unit; $K = 1$ for attackers and $K = 2$ for defenders.	Initial ammunition supply of man J; K $^{\rm s}$ l for attackers and K $^{\rm s}$ 2 for defenders.	Man J's weapon type; $K=1$ for attackers and $K=2$ for defenders. $I=0$ point fire; $I=0$ area fire.	Position of man J in fire team; $K=1$ for attackers and $K*2$ for defenders.	Weapon number of secondary weapon carried by man J; $K=1$ for attackers and $K=2$ for defenders. $0=$ none; $13=$ hand grenade.	Supply of hand grenades for man J; K st] for attackers and K st 2 for defenders.	Supply of signal grenades carried by man J; $K=1$ for attackers and $K=2$ for defenders.
Symbol	ATT(13,J,K)	ATT(14,J,K)	ATT(15,J,K)	ATT(16,J,K)	ATT(17,J,K)	ATT (18, J, K)	ATT(19,J,K)	ATT(20,J,K)	ATT(21,3,K)	ATT(22,J,K)	ATT(23,J,K)	ATT(24,J,K)	ATT(25,J,K)

IBVAR(6,1) is always zero.

IBVAR(6,1)

Table 4-2, Combat Outputs (Sheet 3)

Units	radians	seconds	seconds								
Jefinition	Orientation angle SIAF member J moves to the next point during the current time event.	Time of the next casualty event.	Time of the next detection event, $K=1$ for attackers, $K=2$ for defenders.	0 if patrol K does not break contact; l if patrol K breaks contact. $K = 1$ for attackers and $K = 2$ for defenders.	<pre>K = 1 for attackers and K = 2 for defenders. J = 1,2,,6 (defined below).</pre>	O if the decision is to continue the fire fight; I if the decision is to break contact due to lack of adequate firepower.	O if the decision is to continue the fire fight; I if the decision is to break contact due to lack of adequate ammunition.	O if the decision is to continue the fire fight; I if the decision is to break contact due to the high casualty fraction.	O if the decision is to continue the fire fight; I if the decision is to break contact due to the loss of key personnel.	O if the decision is to continue the fire fight; I if the decision is to break contact due to excessive elapsed time of the fire fight.	O if the decision is to continue the fire fight; I if the decision is to break contact due to the excessively close range of the fire fight.
Symbol	ALPHA(J)	TIMCAS	TIMDET(K)	IBRK(K)	IBVAR(J,K)	IBVAR(1,K)	IBVAR(2,K)	IBVAR (3,K)	IBVAR(4,K)	1BVAR (5,K)	I BVAR (6,K)

Definition	all targets have been recognized.	lack of adequate firepower.	lack of adequate ammunition.	high casualty fraction.	inadequate food.	inadequate water.	time duration exceeded.	Side that sustains next casualty.	he mission.	O Combat decision is to avoid engagement. 1 To conduct an EFS operation. 2 Decision is to ambush. 3 Decision is to attack. 4 Decision is to deploy Claymore mines for ambush.
	<pre>{= 0 Continue. {= 1 Extract:</pre>	<pre>{= 0 Continue. {= 1 Extract:</pre>	<pre>{= 0 Continue. = 1 Extract:</pre>	<pre>{ = 0 Continue. { = 1 Extract:</pre>	<pre>{= 0 Continue. {= 1 Extract:</pre>	<pre>{= 0 Continue {= 1 Extract:</pre>	<pre>{= 0 Continue. {= 1 Extract:</pre>	Side that sust	<pre>{= 0 Continue the mission. {= 1 Extract.</pre>	= 0 Combat dec = 1 To conduct = 2 Decision i = 3 Decision i = 4 Decision i
Symbol	IEXTR(1)	IEXTR(2)	IEXTR(3)	IEXTR(4)	1EXTR(5)	IEXTR(6)	IEXTR(7)	INDCAS	JEXTR	090

Table 4-2, Combat Outputs (Sheet 5)

Unite		spuoses				Springs	e to		meters	Meters
Definition	= 1 if SIAF is the subject patrol (attackers).= 2 if the target is the subject patrol.	Time to the next movement event.	Type of casualty sustained.	Number of the man sustaining the next casualty.	Length traveled by SIAF man J during the current time event.	Elapsed time of the fight.	X-Y coordinates of the break point.	X-Y coordinates of the deployment point.	X-Y coordinates of the engagement point.	X-Y coordinates of the rally point.
Symbol	JSP	STIME	NTYPC	NUMCAS	SLENG(J)	TIMEFF	XYBRK	XYDEPL	XYENG	XYRALY

Table 4-2, Combat Outputs (Sheet 6)

Symbol	Definition	Units
EFSTIME(L)	Time vector containing times of scheduled arrivals of external fire support burst events.	seconds
AIMPTXY	X-Y coordinates of external fire support bursts.	meters
XYMINES(M)	X-Y coordinates of the deployment of the M th mine in a Claymore minefield.	meters
TMINES	Time until target arrives in Claymore minefield.	seconds
TAKOP	Target's direction of movement.	radians
ICOMFT	l if firing is being condicted; O before and after firing	
MOVINF(IUN)	Movement information flag maneuver unit IUN. 0 = if a new check point is needed. 1 = if the current check point is still in effect.	
IGA(IUN)	Current check point for maneuver unit IUN.	
NGA (IUN)	Total check points for maneuver unit IUN until the next objective point.	
XYGA(1,1UN)	X-Y coordinates of check point I for maneuver unit IUN	meters
INRPA(IUN)		
IMPA(IUN)	Current objective point for maneuver unit IUN.	

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Table 4-2, Combat Outputs (Sheet 7)

Symbol	Definition	Units
NARP (IUN)	Total number of objective points for maneuver unit IUN.	
XYARP(N, IUN)	$X-Y$ coordinates of N^{th} objective point for maneuver unit IUN.	meters
KKK	Maneuver unit that last arrived at a check point.	

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5.0 SUBROUTINES

The SIAF model subroutines are presented in Table 5-1 and a brief summary of their function is presented in Table 5-2. The elevation data handling subroutines are presented in Table 5-3. This information is provided as an overview of the SIAF model subroutines. Details concerning the purpose, description, inputs, outputs, flow chart, and programming information are presented in Volumes II, III, V, and VI.

Table 5-1, SIAF Models and Associated Subroutines (Sheet 1)

	CUMMUNICALIONS	EXCOM	21	ICGRE	1CMSG	10,000	ICRAD	ICAUR	•	COMMAND AND CONTROL	PINC	7	ELEVATION DATA HANDLING	MAPCEN	CONVEDT	POTATE	CMPFAN	DEBEAD
	NAVIGALION	NAV		SURVEILLANCE/	DETECTION	TARGEL	AURAL	STRACK	VISUAL	DETECT		SUPPLY MAINTENANCE	10615		HUMAN MAINTENANCE	HIMAN		
F10004	I AKOE I	TARMOV	TARGEN	MOVET		ANCILLARY AND	DATA HANDLING	MAIN	CASEIN	REPIN	RESTART		MOVEMENT	INSERT	SEGGEN	TMDRVR	MVRATE	DROUTE
(MOCCO) MIRAGOLE	JEKKAIN (KECUN)	LOSVEG	VEGCON	MI CSOL	MITFEA	MITLOS	MITCON	ELEV	SLOPE	LIMOBS	TERCON		WEATHER	WETHR		SUPPLY MAINTENANCE	10615	

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Table 5-1, SIAF Models and Associated Subroutines (Sheet 2)

DECISION LOGIC	OPTIMIZATION LOGIC	FIRE CONTROL/LETHALITY	COMBAT FUNCTIONS AND C
MISGEN	01.0610	Krıl	CMAIN
000	0L0G4	LGTH	MO VPLN
DLOGIC	99010	ARAS	MO VDRV
01.061	01067	PKBRP	FORMST
DL0G2	0F0G8	FALOC	POSTURE
DL0G3	69070	PTPTPK	DTBCFR
DL064	0L0G10	ARPTPK	FIRATE
DL065		ARPTI	APROUP
95010	TERRAIN (COMBAT)	IS	FIREOP
19070	DETERR	РКН	WSUBS
01068	DETERM	SUPH	BREAK
69070		NEXTC	RPT
00000	PEOTE		MOR
010611	בלות ב	ETECNAL FIRE SUPPORT	COMMIS
		FFS	REPT
		EFS]	REACT
		EFSTIM	CREACT MINES

Table 5-2, SIAF Subroutines and Their Function (Sheet 1)

TERRAIN

Computes line-of-sight limit due to vegetation and relief LOSVEG

Determines if a target is on a micro-relief feature Computes line-of-sight limit due to micro-relief Computes vegetation concealment VEGCON

Computes micro-relief concealment MITFEA MITLOS MITCON ELEV

Calculates elevation of a particular terrain coordinate

Calculates slope between two points in the AO LINOBS SLOPE

Determines if there is an obstacle, or vegetation, micro-relief, Integrates terrain subroutines into one package or soil polygons between two points TERCON

Determines micro-relief, vegetation, and soil type about a particular terrain coordinate

MICSOL

WEATHER

WETHR

Computes ambient light level, meteorological visibility, temperature, humidity, wind velocity, and rain/no rain verdict

TARGET

Moves targets during the insertion operation Places targets on the map TARMOV TARGEN

Moves targets in accordance with the scenario during non-insertion operations

MOVET

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Table 5-2, SIAF Subroutines and Their Function (Sheet 2)

ANCILLARY AND DATA HANDLING

MAIN - Provides logic to drive the SIAF model
CASEIN - Converts military coordinates to computer
coordinates and converts all times to seconds
REPIN - Initializes subroutine variables to proper values
at the start of a new replication
RESTART - Provides for model execution to start and stop
at preset points

MOVEMENT

INSERT - Simulates an insertion operation
SEGGEN - Generates SIAF movement segment
TMDRVR - Computes time interval for driving the model if
the segment length is zero
MVRATE - Computes nominal patrol velocity and actual velocity
based upon mission and time constraints
DROUTE - Computes check points for dynamic movement

NAVIGATION

NAV

Computes patrol location CEP and target location
 CEP if detection(s) have occurred

Table 5-2, SIAF Subroutines and Their Function (Sheet 3)

SURVEIL LANCE / DETECTION

TARGEL - Eliminates infeasible targets from detection calculations
AURAL - Determines aural detection verdict
STRACK - Simulates special sound effects such as truck tailgate noise
VISUAL - Determines visual detection verdict
DETECT - Integrates detection subroutines into one package

EXTERNAL FIRE SUPPORT (EFS)

Computes results of external fire support when EFS only mode is used Simulates the effects of external fire support in combat mode Computes the event times for external fire support bursts Determines which members sustained casualities from external fire Support EFST IM EFCAS EFS EFS1

SUPPLY MAINTENANCE

LOGIS - Updates available patrol food, water, and ammunition

HUMAN MAINTENANCE

HUMAN - Computes required food and water depending upon work performed and computes human performance degradation due to fatigue, body water loss, and body heat storage

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Table 5-2, SIAF Subroutines and Their Function (Sheet 4)

OPTIMIZATION LOGIC

COMMUNICATIONS

M - Calculates external communications statistics and updates battery supply	IC subroutines and decides whether internal	ailable between maneuver units	Checks and updates the maneuver leaders supply of signal prepades	
Calculates external supply	Integrates the fire	Communications is av	Checks and updates t	Selects a messenger
•	•	1	•	ı
EXC ON)!	10001		1CM36

Table 5-2, SIAF Subroutines and Their Function (Sheet 5)

COMMUNICATIONS (cont.)

Determines whether line-of-sight exists between two maneuver unit leaders ICRAD ICAUR ICL0S

Determines whether two maneuver units can communicate using radios Determines whether a receiver can detect an aural message

COMMAND AND CONTROL

Determines detection verdict(s) from the possible detection possibilities

Table 5-2, SIAF Subroutines and Their Function (Sheet 6)

TERRAIN (COMBAT)

Table 5-2, SIAF Subroutines and Their Function (Sheet 7)

DECISION LOGIC (Cont'd)

FIRE CONTROL/LETHALITY

- Controls the operation of the remaining fire control/lethality subroutines - Allocates point fire weapons, assigns area fire as appropriate, assigns	hand grenades as appropriate - Computes the area of responsibility for each firer and computes which targets are in each area of responsibility.	- Computes a figure of merit for alternative firing strategies	 Computes the optimum point fire allocations for all firers in the point fire mode 	- Computes casualty data for the next attacker and defender casualty	- Computes kill probability for each firer using a rifle or machine oun	- Computes kill probability for each firer using a grenade launcher	- Computes the total single shot delivery error for each weapon type	- Computes the probability of kill given a hit	- Combutes individual supported tates
		و يو	<u>.</u>	ပ္	Æ	¥			
KILL	ARAS	PKBRP	TALUC.	NEXTC	PTPTPK	ARPTPK	S	<u>₹</u>	SUP

Table 5-2, SIAF Subroutines and Ineir Function (Sheet 8)

COMBAT FUNCTIONS AND C2

Table 5-3, SIAF Elevation Data Handing (Sheet 1)

ELEVATION DATA HANDLING

 Produces FORTRAN - compatible tapes from Defense Mapping Agency (TOPOCOM) Digital Topographic Tapes 	 Selects and/or thins terrain elevation data for the area of operation Provides for rotation and change of interval distance between elevation 	AD - Loads a selected section of the available map area into computer	. Condenses the input area elevations in computer memory
CONVERT	MAPGEN ROTATES	CMREAD	REREAD
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Sections 6.1 through 6.4 describe a test case which illustrates the use of the reconnaissance model while Sections 6.5 and 6.6 present a combat model test case.

- As part of the SIAF program, a mocel verification plan was developed and a test using actual patrols was conducted. Concurrent with the test, the SIAF System Model was exercised for the purpose of simulatin, this test and providing data for comparison purposes. This section presents a sample case based upon the test scenario. Included is a qualitative description of the test, a description of the model input data consisting of terrain, weather, the SIAF operations plan, and the enemy situation, and a description of the outputs of the model.

6.1 QUALITATIVE DESCRIPTION OF THE TEST PROGRAM

The field test was conducted at the Hunter Liggett Military Reservation located near King City, California, a facility of the Combat Developments Command Experimentation Command headquartered at Fort Ord, California (Monterey). The test exercise was conducted in a relatively rugged and remote valley which is also a part of Los Padres National Forest. Figure 6.1 is a photograph of a map of the area of operations which represents a geographic area of approximately 17 square kilometers. The patrol mission-scenario (including an aggressor scenario) was developed by the test conductor employing inputs from the test team members. The mission was basically one of reconnaissance which consisted of surveillance of a road suspected of being an enemy supply route, by a SIAF patrol moving primarily at night along the high ground on one side of the valley. Combat was not entered or simulated and live ammunition was not carried.

As shown by Figure 6.1, the distance between the projected insertion and extraction points is approximately 6-1/4 kilometers; however, the route between checkpoints and projected patrol bases is not a straight line nor did the patrols follow a simple point-to-point route. The actual route traveled by each patrol was approximately 9 kilometers long.

Each patrol spent two days in an objective area near the center of the route. This area contained several OP's and bases among which the patrol moved. Aggressor activity existed in the area, some of which was along the roads. For experimental purposes, this area was instrumented to determine exact positions and ranges of detection between the SIAF patrols and the aggressor.

The 5 1/2 day mission was performed by each of 20 patrol teams provided by the 3 participating services:

Army Special Forces 10 teams U. S. Marine Corps 5 teams U. S. Navy Seals 5 teams

Each six-man SIAF patrol team was given the same mission, checkpoints, and basing areas, and was exposed to the same aggressor scenario. Patrols moved primarily at night. During the day the patrols established bases from which they monitored the primary road or conducted related reconnaissance and surveillance activities. The sample case described herein (referenced as scenario 1) treats only the first of these patrol missions.

6.2 GENERATION OF BINARY TAPE 8

As described in Section 3.0, Binary Tape 8 is generated from card input. Because of the requirement to duplicate the test situation as closely as possible, detailed terrain and vegetation data were first gathered. This section describes that task.

As previously described in Section 2 4.1, the terrain resolution study for the Hunter Liggett area indicated a substantial increase in accuracy with 50-meter resolution as compared with that obtained for 100meter resolution. Since the objective of the Hunter Liggett test was to validate the SIAF model, it was considered necessary to use 50-meter resolution. Since the only available digitized data were 100-meter resolution, a decision was made to input the elevation data for the area of operations shown in Figure 6.1 by hand. For this purpose, the map shown in Figure 6.1 was enlarged and a 50-meter grid was overlayed on the map. Then elevation data associated with each corner point of the grid were recorded on computer input sheets. The resulting 7,105 points took approximately two weeks to record. A namelist printout of these resulting data is shown in Figure 6.2. These data, which were used to generate Binary Tape 8, are in feet since the map used for this purpose (Reference 3) contained elevation information in these units. Data were subsequently converted to meters in the computer program.

It should be pointed out that Army digitized terrain tapes of various areas of the world exist. These tapes obviate the necessity of inputting

Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sneet 1)

Figure 6.2, Namelist Printout of Sample Case Elevation (2) and Vegetation (V) Data (Sheet 2)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 3)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 4)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 5)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 6)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (Y) Data (Sheet 7)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation(V) Data (Sheet 8)

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Figure 6.2. Namelist Printout of Sample Case Elevation (Z) and Vegetation (Y) Data (Sheet 9)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (Y) Data (Short 10)

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (Y) Data (Sheet 11)

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1230. 1160, 230, 1160, 1350, 1300,1 243 1363, 240, 240 160 1300 460, 1220 1175 1325 1180 200 1140. 2609 2501 360. 263. 105. 4004 160. 300. 460. 2400 160. 310. 510, 220. 160 315, 120. 520, 220. 160. 340. 120, 530. 220, 18C. 360, 540. 430. 230. 120, 120. 120, 1300 100 260, CRO. 450. 100. 170, 240. 300. 460. 180. 280. 1900 440. 230. 166, 090 240. 160. 320, 240. 280. 130. 240. CRO. 1180. .080 580. 130. 11 70. 1175, 3000 250. 250, 1100. 410. C80• 240, .300 .240. 160. 2000 240. 1240. 266. 240. 47C. 210, 185, 260, 140 280, 1270, *1160, 2:30 230, .049 500 175. 1000 260. 4004 260. 500. 200, 220. 2003 3200 2500 3.30° 400. 280. 2000 2200 5007 140. 28C • 200 150. 260. 193, 150. 4027 643 200, 240. 200. 203, ,113, .000 240, 210. 300 4+3. 210, 510, 180, 150. 200. 663, 2 e 0 . 180. 360. 320, (C) **5007** 210. 540 400% 160 330, 4004 300, 200, 300 560, 320, 235. 230. 570. 340, 200 2005 100 550. 360. 2005 30g. 3000 36.3, 450. 2200 185, 3400 540. 370. 220. 100. 330. 2200 2000 4017 300. C:7 150 440. 2003 180. 280, 6009 380. 2003 155, 320. 500. 330, 250, 160, 500. 390, 250. 160, 300, 560, 4004 2000 175, 300. 550, 440. 220. 300. 640. 430. 200.2 210, 3000

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet I2)

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1203.		900	202	1350.))	774	1210,	195	380			220	1195,	390		~	1250,	0	0		3	1260.	21	39	(270	1260.	777	360	i	10101	י עמי	7	350		200	1250.	212	¥
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1150.	1333.	1750.	1323	14.33	1300	170.1	1330.	1243,	1409	1360.	1780.	2	1220,	9	3	3	50	1215.	1450.	20	C	ç,	7	1420.	1300.	20	3	1220,	1340.	1250	1723.	1365	1225	13.50	1340,	1670.	1350,	1230.	1260,
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1200,	13230	1629	1433	1725	1340.	1640,	1440.	1230.	1220,	1360.	1600.	1510.	1260.	1225,	1340.	1629,	1433,	1265,	12400	1370.	1620,	1450.	1200	1250.	1325.	loui.	1510.	1240.	1245,	1310.	1600	1420.	1240.	1235,	1300	1703.	1460.	1240.	1230.

Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 13)

*nes 1-2	1240.	*	~	512	1205.	730		0091	275	250	310		9	1260.	53	\$		62	1260,	36	58		1640.		1390.	1240.		62	1270.	7	250		1680.	•	1380,	1320.		1720.	
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	¥ 2.	0 '	7.5	7.7	71.	* 1.3	-	~	\$	1200	1373.	1130.	しゅうりゅー	1350.	1223.	•	1123.	•	2	5		110)	-ú	1+23.	ď١	1		•	1473.	C.	1300		2000	S	1290	•0	1240.		
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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 14)

12930		•	1780.	310	*	420		500	745	1370.	024		1900.	353	3	400		900	1350.	370	•		96.	1340.	400	473	Č	000	707	1493		980	360	1440.	520	;	2000.	3	400
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1.500	7	7	3	9	32	7.	9	Ş	3	33	30	<u>*</u>	20	9	7	32	27	CT	ŝ	3.5	32	9	~	25	3.3	35	2	₽.	מ מ	1380	91		3	2	3	*	2123,	5 7	4
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1520.	: 2	, 7,	25)	513	202	4	320	150	633	?	360	33	7	5	97	30	£,	77	3	7	3,	4	Ċ.	5	7	7	45	2	• ·	1 5	! !		3	310	350	50	2080.	7 50	3
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Figure 6.2, Hamelist Printout of Sample Case Elevation (Z) and Vegetation (Y) Data (Sheet 15)

1523.	340	1395.	460	510		999	330	460	1530.		980	400	1460.	520		970	390	1450,	510		930	1430	420	433		930	014	1420,	6 00	í	960	14304		1420.		020	1425.	200	420	
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1453,	17.	450	7	7	91	33	3	5	9	1	6	7	3	3	1	90	48	7	20	15	98	50	45	50	15	80	20	47		1160.	ر ح	3	Ž	,	22	90	1500.	-	Ğ	Č V
1420.	3	4	*	7	$\stackrel{\sim}{\sim}$	77	53	*	25	21	2	5	4	54	21	3	24	33	Š	2	Š	S	35	•	3		2	350	* 5.	1140	3	30	330	큵.	160	2	29	12	3	\sim
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1230	3	3	₹,	3	7	3	3		3	3	0	8	35	9	39	3	3	3	30	9	97	2	9	2	20	ب ح	3	36	7	7	9 9	D (?	* !	2 6	<u> </u>	7	7	2 :	32
1333,	3	٠ ح	Ř,	9	25	50	ري ص	S	3	3	20	6	<u>ج</u> ا	37	3	3	8	3	37	Ş	Š	20 i	5	36	9	3 9	` :	3:	9	•		7:	7	' بيد د جو	Ž;	3	Ž'	Ý	7	Š

16906-6008-R0-00 (Revised July 1973) Page 6-19

Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (Y) Data (Sheet 16)

1230. 100. 050. 2130. 520. 1450. 340. 500 340. 540. 200. 1001 1480. 140. 220. 340. 470. 2163. 1240. 091 •1300 210. 290. 500. 270. 300 270. 1210. 543. 350. 900P 383. 400 200 020 £30° 380. 200. 150. 088 2000 930. 300. ***00** 380. **400** 140. 360. 3000 **.** 930, 30, 463. 930. 1000 450. 440. 320. 350 160. 1000 420. 950 4004 040 5:00. 000 0,0 Sec.

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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 17)

)
1420. 2130. 2130. 1460.	1 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	2100. 1460. 1560. 1570. 1560. 1560. 1560. 1560.
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4400000		215.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00 115.00
ふうとう ひろん		
またまりまら ないよう		2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
1330. 1430. 1340. 2160. 13670.	1 N N D D D D D D D D D D D D D D D D D	
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33m-043		22000 12000 12000 12000 12000 12000 12000 12000 12000 12000 12000
4000046	20000000000000000000000000000000000000	2080. 1500. 1500. 2020. 2020. 1250. 1250. 1550. 1550.

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Figure 6.2, Namelist Printous of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 18)

020	,	1076			000	794	1340.	430		5	3	1330,	3		000	1570.	330	160		000	1650,	240	100		2040.	2	290	530		2080,	3	780			030	1570,	360	200	(1950,
1180.		7	7 4	9	8	52	2	Ž	Š	8	Š	Ř	3	2	0	2	7	S	1	35	7	35	ž	-	8		3	Š	2	2120.	3	Š	25		200	3	450	1620.	2	02
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1140	,	3 1	2 4	1150	1	62	51	45	9	12	20	3	1,4	77	ċ	1660.	3		56	90	79	1	1450.	20	77	7	+1.		28	2260.	9	7	20	52	77	63	2	79	2	20
1150.	• ;	ָה היי	7	7 -	7	7	55	?	•	2	2	56	45	53	?	14	5.2	=	260	2	Ť	4.	1460.	\$	54	25	7,		035	2200.	Ĉ		23	32	91	47	# E	1540.	3	5
1130	•	7 1	7	•	7	16	5	45	7		73	S	÷	7,	2	90	53	*	3	~	1750.	7	\$:	9	T P	3	7	\$	2140.	8	•	50	35	5	2	2	1530.	ţ	B
1220.	,	, ,	7 ú		7	3	2	.0			6.5	5	7	3	20	82	Ž	15	34	2	S.	3	1440.	;	ċ	'n	54	3	4	40702	78	=	25	45	50	12	57	4.7	45	さっ
1260.	3	3	, , c	7 7	2	3	•	7	7	•	4	53	*	2	7	5	S.	7	7,	5 C	56	57	1400.	7	3	88	26	35	2		3	1500.	40	20		95	200	1400	Š	
1430	_	, ·	7 1	ان الر س ال	15	7	7	4	35	~	25	3,4	37	3	25	7	9	34	3	2	20	79	32	4	12	75	58	32	*	2 *	~			Ð	•	-	Ş	1320,	Õ	
1333.	2	T:	7 6	, c		25	3	35	6	15	96	55	34	75	5	70	20	32	3	20	Ç	69	3	4	2	3	99	25	3	7	~	3	30	4	7	Ö	46	Ť	S	7

Figure 6.2, NamelistPrintout of Sample Case Elevation (Z) and Vegetation (Y) Data (Sheet 19)

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																													. 1	1870.											
9	1220	•		1983	1660,	1330.	1550,		36	1720.	1340.	1550.		1960.	1750.	1340.	1420.		35	1800.	1330.	1370.		1970.	•	1340.	1330,		1960.	1900.	1295,			*	1900	2			2000	1880,	1340.
2*1540	* 7 7 0 •	7001+2	1200.	205C.	1630.	1410.	1450.	1170.	23463	1630.	1420.	1480.	1160.	204C	1730.	1400	1470.	1140	202 C.	1780,	1400	1300.	1140.	2020	2*184	1400.	1300	1140.	200C	1900.	1330,		11.00	1980	1940,	~	•	•	2000	1940,	1380,
1560.	• 00 • 1	1620.	•	2140.	1630.	1520,	1530,	1240.	2140.	1660.	1510,	1400.	1180.	2100,	1700.	1490.	1440	1160.	2100.	1760.	1460.	1300,	1160.	2100.	1740,	1470.	1280.	1160.	2060.	1840.	1380.	2*126	10/11	502C	1900.	1400.	ŏ	Ē	2040	1960,	1400
1543	10001	1077	CC F 1 = ?	22.20.	1620.	•	1560.	1/00.	1240.	1540.	1540.	1500,	1230	4550.	1699.	1550,	1400	1130.	2220.	1700	1520,	1340,	1200	2180,	1700.	1550,	1350,	11.50	71 6C.	1740.	1 +63.	1240	•	51 6 Q •	1860,	1440.		=	210C.	•	1450,
٠,		12000	11.00	2170.	1500.	2×1×3	154),	1270.	2 2 3 3 4	1620.	1030.	1400.	1269,	22c0,	1623,	1600.	1430,	1240.	2260,	1630.	1630.		1220.	•	1730,	1570.	•	1230,	5269	1740.	1540.	1260.	11 90	77 CO.		1500		1140,	22200	#	1530,
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1700	10791	1 * 4 7.	1450.	2153.	16HJ.	-	1453,	1423.	2*2100	1753.	1720,	1380,	1380.	2150.		1750.		1330.	2269,	1773,	1 753.	1250.	1260.	2220,	1820.	1720.	159C.	7*1/60	2210,	1430,	. 🕶	1 500.			3*1800	1690,	4*150°			1 Bod.	•
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Figure 6.2, Namelist Printout of Sample Case Elevation (Z) and Vegetation (V) Data (Sheet 2D)

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2050. 2020. 2000.

terrain data by hand as was done for this sample case, and normal use of the model for various SIAF studies would probably not require as extensive an effort as was undertaken for this project.

As with relief, considerably more effort than normally required was taken to input vegetation data since the objective of the simulation was to duplicate as best as possible the test situation. As described in Section 2.4.1, a vegetation survey of the Hunter Liggett area was conducted for the purpose of obtaining input data for this simulation. During this survey, aerial photographs of the area were obtained, a ground survey was conducted, and the vegetation in the area was categorized according to the classification scheme shown in Figure 2.7. From this information, the vegetation data for the 50-meter grid square resolution were recorded on computer input sheets. The last part of Figure 6.2 shows namelist printout of these data from which Tape 8 was generated. Because of the difficulties of correlating the aerial photograph with the map, this exercise took approximately three weeks; however, normal use of the model would require a far less extensive effort. In fact, with the aid of the namelist input the vegetation of the entire area could be input with one card if the user desired to specify a constant vegetation class for the area.

6.3 USER IMPUT AND DATA BASE

Values corresponding to the variables of Tables 3-1 and 3-2 are presented in Figure 6.3. The data base in NAML1 consists of the first three pages of this Figure. The user inputs with the exception of the target data are in NAML2 which starts on the third page of Figure 6.3, while the target data (NAML3) starts on the seventh page of Figure 6.3. The user input for the sample case has been organized alphabetically so there is a one-to-one correspondence between this sample case and the inputs described in Section 3.0.

In order to exercise the dynamic route and external fire support eptions of the model, this sample case was organized as follows: For targets 1 and 2, the decision rule used was for SIAF to move toward these targets i an attempt to identify them. Once targets were identified, external fire support was to be called on the targets. For targets 3 and 4, the decision rule was to avoid these targets, if detected, by moving around them. For

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Figure	5.3, Namelist	Printout o	f Sample Case	User Input	(Sheet 17)	1
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targets 5 through 51, no dynamic movement was used. Instead, once detected, these targets were removed from the simulation and subsequent identification was not attempted.

6.4 MODEL OUTPUTS

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The outputs of the model consist of detail and summary printout. Detail printout presented in Figure 6.4 begins with some target transformations and then shows the X and Y coordinates of the SIAF location, the target currently being considered under the dynamic route option, and the current time in seconds. The second page of Figure 6.4, for example, indicates that IDTAR equals zero. Thus, there are no targets currently being considered for the dynamic route option at the simulation time shown. The third page of Figure 6.4 indicates that the dynamic route option was taken by the patrol at the time shown. Subsequent printout reveals that the patrol was moving toward the first target in an attempt to identify it. Finally, the fifth page of Figure 6.4 shows the result of an external fire support mission which was called on target number 2 and later on target number 1. This detail printout continues and presents a time history of a portion of the operation by showing when a dynamic route is used, the results of the external fire support missions, and the location of the patrol throughout the entire mission.

Summary printout of the simulation of the mission for all 51 targets is presented in Figure 6.5. Table 6-1 presents a brief description of these targets. For this summary printout, the dynamic route option described above was not used; hence, KREC(IT) was set equal to zero for all targets.

Included in Figure 6.5 are statistics pertaining to visual detection, target identification, aural detection, target location, movement, navigation, communications, supply maintenance, and human maintenance. As an example of the correlation of these results with the physical situation, Figures 6.6 and 6.7 are presented. Figure 6.6 shows the first six targets in the vicinity of the star cluster turn while Figure 6.7 shows the time line diagram associated with these targets.

A study of these Figures and Page 1 of the output data of Figure 6.5 reveals that for 5 replications, targets 1 through 3 were never visually detected by SIAF while targets 4 through 6 were always detected. Page 37

of the output reveals that the reasons for no detection on target 1 were primarily due to vegetation while targets 2 and 3 were always masked by relief. The aural detection statistics of Page 10 of Figure 6.5 indicate that targets 1, 2, and 5 were always detected by SIAF while target 4 (8 personnel) was not. Auril detection of target 3 and 6 was not feasible.

With respect to defictions of SIAF. Page 19 of Figure 6.5 indicates that target 4 (8 person ml) visually detected SIAF once in 5 replications while Page 28 reveals no rural detections of SIAF by the enemy.

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Figure 6.4, Detailed Computer Output (Sheet 2)

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Figure 6.4, Detailed Computer Output (Sheet 6)

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AFLY STAFFILITA, PHILL	15/4.032	110011	3	174048
F. Y. 14F. 10147 . 111	1577.840	Š	7	071441
· VS IAF	1370.301	1360000	4	14141
Afors lare luter elling	42101641	1303.32	.5	14143
to Valario Lul	1263.353	0.00 €. AG¶	t	14+254
_	4 44.03.4	10: 10 150	*	11103
YSTATO LUTATE LIT	133/0543	1000000	•	134310
ווישוחויארו	1301.544	1 104.233	·	194461
. YSIAF. IPTA ITI	1201051	10000	,	1 14434
VSIAFE !	1151.03	100.00+23		194530
1 14. 1	1,000	1304061	ر .	1.9+6.5
afortalary lutanout line	1237030	1401.105	¢	34046
Arryslar. IUTAr , 111 a.	1287.30	130	۲,	14.737
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ASIAFOYSTAFO ICTAR OIT LIE	1234.031	ついん・つつだり	د،	19479.3
Fe Y S LAFE I GTAN E LT 1 16	1203.346	145:000	0	19481
Forsiare Lutar ell lin	4.35.1	2 10000	7	195632
Forstate totate attice	16236.30	4 100 - 430	n	145017
te Yaldfelulatellini	1232.000	2 23.3. 33.2	ı	195114
F. V. LAF. LUTAN, IT LAE	1227.875	2076.+64	د،	145162
F. VSIAF. LOTAK, LTIME	1221.675	2074.444	0	145253
E. T.S. IAF. INTAK. ITIME	1227.075	2079.988	"	195054
Forstafo tutaro 1114	1227.875	2.914.430	ر .	140455
111	144 1.012	2074.403	٠,	147050
Fr YS LAFE LUTAF ELT LIL	1427.315	2014.403	-	1,7657
Ξ	1227.875	2014.440	^	100567
. Y SIAF . IUTAN . IT	1227.075	2014.480	()	144032
AF. YSIAF, LUTAR, IT LIL	1-1-1-075	2074.443	2	190633
_	- x •	2074.438	7	144234
_	14:7.815	2074.433	ر.	1.99835
Are Yo Lafe Lu TAI. el Tl'II	1227.575	2374.433	د.	29:3436
Y > [4F .]	1227.872	2374.400	ı	201033
10 ten 111	1427.675	2074.434	(1	70107
AFEYSTAFE ILILIARETTIME	144.70072	2)74.438	c٠	20105
VSINFO LUINO 0111	122 1.515	21/40433		233463
Yslatel	14.1.015		'n	102467
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ate Yalate Ittino attine	1-1-015	22744433	د.	233431
7	127 7.475	7.00.00.3		June 1

Figure 6.4, Detailed Computer Output (Sheet 9)

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Figure 6.4, Detailed Computer Output (Sheet 10)

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1.0.1.1	1.01.0	1.41.812	1.4.1.315	1.27.673	1 1-875	17.075	1221.617	1227.975	1001	1227.37	1.010	12-7-012	1. 27.875	1227.075	1447.012	1227.512	17:1.31	142 1.013	1-1-4-1-1	4203000	1.040.0	46.16.24	10000	1:34.037	11010400	110 1043	11000600	115775	1150.000	1132.500	140000	1 12 24 20	1 > 1.31+	1327.013	1327.013	1016-31-1	17:1:41	10.0.0	1300 1	410.012	1220123	15 1. (0)	244.0.48.3	145.64.3	
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Figure 6.4. Detailed Computer Output (Sheet 11)

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Page	6-55

Figure 6.4, Detailed Computer Output (Sheet 12)

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_	101.100	*****	٠,	233032
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AF. YS LAF. LUTAN . IT LAE	101.61	24:0.463	د.	741551
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	1.7.06.	£ \$ \$ \$ \$ \$ \$ \$	•	41767
	31:01.7	1+10000	,	K62767
IAF, IUIMP , I	547.737	14.5.44.3	:,	106757
AF. YS IAF. LUTAN. LTILL	6-13-7.1	アナナ・コンドン	ر .	793501
AFLYSTAF LIUTAL LITTAL	0.16.7.1	744.675		2.4 5.1.1
láf , lular , l	011.111	25.30.44.3	•	233001
-	t. 1 7.7	C+4.00c;	•	7 14407
AFEYS LAFE LUTANOLITION	343.737	444	יכ	204452
AFOYS JAFO LUINE OF FLAR	101.640	2866.444	7	245033
AF. YS LAF. LUTAL., 111.4.	940.101	£400007	7	233034
AFa Yaldı a lütar alı tlek	1771068	2000.443	0	23,235
AFO YO LAFO LOINE OF The	540.137	25.0.443	7	202030
	895, 737	2400. + + J	3	162187
AFEYSTAFE TOTALETTINE	0.70.137	2500.449	၁	160062
AF. YS IAF, IUTAR, ITINE	890.117	2800.444	-	248032
SIAF. YSIAF, LOTAR, LTEXE	840.737	£ + + • 9 7 9 7	\$	289683
Fersiate LUIMER ITIME	274.137	40,000	7	213073
AFOYSIAFO INTACOLT IL	811.11	£300.443	*;	29.392.5
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10[[0.7.7.1	1.230.44.1	~ 	24.1490
YS lafe Lulariel	310.13	2006.444	>	2911.34
JIVE !	693.131	7300.+4)	-	291049
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Ators late when I like	5.10.171	アナナ・コン フ	7	47164
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afora laro lutaro l'Il de	111.06.0	4+4.0707	ر.	109167
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Areys late luTanel I live	813.137	2010.449	2	291654
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re YS Live LUTAN . I Tin	1.146	236 20449	.,	29+X L
AFOYSTAFO LUTANOLITIAL	1:1.60	6.4.4.00p.	7	245231
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A CARACTAFA INTA A LITTLE	3-11-1-1	23000 049	٠٦	29/1603

Figure 6.4, Detailed Computer Output (Sheet 13)

1 10000	260263	\$0.10.55	77776	2.426.6	3,46,43	1,060,0		51/033	102000	5.3465	311433	1:2416 0	5 383634	Et Jele o	7,007	274575	517563	. 313124	315725	0 31330	C 514673	.) 34.972.5	2 11.752	051515	•		\$10074	1 SlyJol	2 327175	5 32321	12472	3 323432	***************************************	367645	521370	T++275	1 20775	3.210	328102	1 22478 7	324032	324033	32524	3, 3,55,5	
7 9 9 0 0	1 26 00 76 7	2.5 \$ a 2.2 C a	•	1 + 4 + 0 / 4 2	1.1.6.00	- + + - 7 - 7 - 1	20.00.00	f.44 * 7) p.7	**************************************	23.40.40.4	(* * * * * * * * * * * * * * * * * * *	Pr. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	E # # * 7 "C "	4990000	*******	200000	6 * * * * * C * * C * * * * * * * * * *	2303.4.0	2360.043	7 * * * * 7 7 7	2002-4-1	チャチ・ロジョウ	- dCo - 44 *	2465.444	7300.441	2000-464	2450.044	7 * * * 0,000	7. 4. 0 1p.	54.4.00P2	10130044	2 + 2 · 0 · 0 · 7	13.00.411	7 * * * 0 * 0 * 1	1 2 2 2 2 3 2 3 2 3 2 3 2 3 2 3 2 3 2 3	20000 140	7.5.0.2.2	200000	1000000	25,0000	である。こうでは	2000-461	1363.443	2 dl 0 . 44 /	
	1(1)	101 01 8 8	7 7 6 7 7	1 10.40	1.1	1:1.600	21.7.5.0	31731	1.1.10	1:1.6:00	51.01.1	101.000	5-15-131	T. T. s. t.	1.1.1.1	111.	0 1. 131	1.1.01.3	44.01.1	101.000	211.1	1:1:05.8	1(1.7,40	d.17.7	dvc. 1:7	~	1.1.1.1	0 10.101	1.1	1.1	101.000	10.7.1	1.1.1.	1.1.10	1 lears	1.1.1.6	1:1:1:	34.0131	11 Tock :	1.1.00	1.1.040	111.010	101.40	~	:
		THE LANGE WALLS AND THE STREET			1 . 1 × 1 × 1 × 1	IAF. YS LAF.	LAr. Yolnfel	LAF. YS Life	Tark Lynna	line Yo Intel	1 AFO Y S Link . L	F. Yslar,	lafe Ystare to	SIAFIYSL	ALALO YS LAFOL	144.42	SIALLYSI	SIAF, YS	Slare Yalafei	IAr. ValAr. LUIAR. I FI	NIAF. YNIAF.	JATOYS LAFO LUIANO ITI	SIAF. V.SIAF. LUIAR OLT	SIATE VSIATE LUIATE TO	1At- 13 13F - 10 13r - 11	VIAF. VSIAF. LUTAN. LT	SIAF. YSIAF. IUIAK. 171	SIAF. YSIAF. LUTAR. LTI	LAP. YS LAF.	5125	1 Are Yalmfel	LAFEY	101117	125.45.141.1	Jan. Yslar .	1 - 1 - 1	1 14 . Y 2 i Ar 9 L	A Late Yalmie	Ar. VSIA	VI 15 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			125.42.42.1	SIAFOYSIAFOL	*

Figure 6.4, Detailed Computer Output (Sheet 14)

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AF-VC Info Lutar .	50 C C C C	F # # 100 1	: ר	161026
TOTAL PROPERTY.	101.00	C400000	ر	363638
AFO TO LAFO LOIL	440.127	2500.443	.,	325739
XVIAFO VS IAFO ICTECO I TIME	690.111	2000.443	()	327C4C
AFrYS	177.6	2400.441	Ü	327341
XSIAF, YSIAF, LUTAN, ITIAE	649.737	2400.443	ı	1677621
AF. YS [AF.	440.101	\$ 300° 443	. >	327751
XSIAE, ISIAE, IUTAE, LITIAE	(ښت ۱۹۶۸)	2943.700	3	324018
XSIAF, YSIAF, ICTAR, BILL AE	043.1.3	2330033	رم	320057
XSIAPO VSIAPO LOTATO LTI 4E	533.5.0	2324.0.40	,	523303
XSIMFe YS IAFe LOTur. el Ilite	13.716	2400.000	״	32,300
KSIAFOYSIAFOIUTAROITIAE	150,030	2-150.5.7	ج.	32dul4
_	757077	20000	•	324734
_	7 10	1.131 . 301	.,	36 36 39
AFOYS LATOLLT	011.000		,	100424
XSEATO YS LAFO LUTAR OF THE	300° 500	1001023	,	32117
XSIAFeYSINF IDIA + 11111	20.20174	3.20.	נ	523512
KSIAF, YSIAF, IDTAK, ITINE	01 3.4 db	3.256.133	>	32+35C
Kolato Volafo lutar o LT inc	cl 3. * 33	3250.133	.,	32,381
âFrYslatr	21 22 4 30	\$120.13	:	324471
	C1 4.544	3103-000	2	32 3034
ASTATOYSTAFO ILTAIN OF THE	0.2.033.	\$150.00	•••	321020
ASIAFAYSIAFA IUTAR ATTITIC	946.344	3	. ,	90000
ASIAF, YSIAF, IUINF , ITINE	024.673	3250.000	٠,	337248
IAF, YS	023.275	3303. 133	ی	333490
KSIAE, YSIAF, IVIAK, ITINE	949.231	1423.000	2	333732
XSIAF, YSINF, IDINF, ITINE	025.234	3463.336	.,	337974
ASIAP, VSIAF, LUIMA, ITIME	45.623	1410.073	J	331042
KSIAF, VSIAF, IJIAK, ITINE	46.620	1410, 170	ڻ	431105
KSIAF, YSIAF, IUIAA, ITIME	231.210	3424.173	i,	331201
XSIAFO VSIAFO INTAR OF TAME	e le o le c	3424.113	ر.	331291
	(45.50	5+40.044	7.	331412
XSIMFOYSIMFOLUT	45.034	145 is Jun	Ç,	101166
ALLATOVALLE OLOTATOLICE	606.660	1500000	r,	331750
X2 MF. YS LAFE LUTAR & LT LAG	105.500	25voel yo	ر	33177c
XSIAFO VOIATO ICIANO ITIN	7,30403	3552,303		332024
_	15.0.1	1503.743	Ü	132130
	100.31	1266.344		33220
IJIA: . ITI	(10.01)	120 144	`	3366.37
ASTAFOYSTATO LUTA: 0171%.	1.0.363	1500.000	•	224638
KS Lafe Y s Late 1 LI At e 1 1 1 de		150. 0 346	- 1	33+0c.1
LATO VS LATO LUTA. O LTL.AL	700.013	150 dtt	• >	11+532
=	705.343	***	٠,	777025
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Figure 6.4, Detailed Computer Output (Sheet 15)

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3+ 1 1 1 0 1 7 1 O 1 O 1	703.313	\$200 . 344	3	3 3 2 8 7 3
X5186. Y5 12F. 10 127. 11 120	leu. 313	3202.364	0	335423
IAF, IUTAK, ITINE	700.313	3300.044	•	73240
KSLAF, VSLAF, LUIAN, LTIME	700,31,4	3502.444	0	335954
-	luo. 113	3502.344	٦,	337.162
ASTAFO VSTAFO LUTANO ITLAE	100.313	1266.444	- -	355015
ILIAKIU!	Too. of 5	3304 344	•	336016
 	700.313	3304. 344	P. 3	335161
-	700.313	1206.064	. >	333470
_	700.313	3502.344	(3)	137621
12 12Fo V. L. T. L. L. L. L. L.	705.313	3504.000	و .	337047
F. LUITE . LTLAL	115.313	3362.844	~	772757
r. LuTar . LTL.1c	luc. 313	3362.344	٠,	19/16
XV LAF. V. LAF. LUIAX. LILE	750.515	1200.044	၁	351277
IF. IUIAF . ITI 1L	Too. ols	3202.344	?	£ 1085 £
M. L. A. L. L. L. L. L. L. L. L. L. L. L. L. L.	106.313	3242.444	9	334060
	100.313	3266.544	O	343572
Kolato Yolaro lufero 111.1	100.313	1256.344	٠٠,	*80155
AFE LUTAL ETTINE	lute sks	1204.34+	د.	335152
LAF. IUTAK I TINE	700.313	3562.344	0	797965
	106.313	3202.944)	334239
AF. YSIAF. LUIAN, ITINE	706.313	1562, 044	9	334310
AF. TS LAF. LUTAR . LT Lit	7.00.31.3	3502.044	၁	10006
	706.313	3502.044	٠.	7777
XSIAF, VSIAF, IDTAN, ITINE	700 s s s	3294 . 346	٠,	3344KT
_	706.313	3202.04.	0	334521
10TAR 1	706.313	3542.344	Ġ	334535
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Figure 6.4, Detailed Computer Output (Sheet 16)

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Figure 6.4, Detailed Computer Output (Sheet 17)

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Figure 6.4, Detailed Computer Output (Sheet 18)

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Figure 6.4, Detailed Computer Output (Sheet 19)

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Figure 6.4, Detailed Computer Output (Sheet 20)

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Figure 6.4, Detailed Computer Output (Sheet 21)

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Figure 6.4, Detailed Computer Output (Sheet 22)

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Figure 6.4, Detailed Computer Output (Sheet 24)

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Figure 6.4, Detailed Computer Output (Sheet 25)

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Figure 6.4, Detailed Computer Output (Sheet 26)

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Figure 6.4, Detailed Computer Output (Sheet 27)

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Figure 6.4, Detailed Computer Output (Sheet 28)

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Figure 6.4, Detailed Computer Output (Sheet 29)

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Figure 6.4, Detailed Computer Output (Sheet 30)

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Figure 6.4, Detailed Computer Output (Sheet 32)

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Figure 6.4, Detailed Computer Output (Sheet 34)

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Figure 6.4, Detailed Computer Output (Sheet 35)

Figure 6.5. Staf survistance statistics (Page 1) worsts ticosts scruasio 1 worsts applications

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Figure (.5. STAF STOVETHEANCE STATISTICS (PAGE 2) HUNTER LIGHART SCENARIO 1 R MERLICATIONS

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Figure 6.5, STAF SURVEILLANCE STATISTICS (PAGE 1) HUNTER LIGGETT SCENARIO 1 S REPLICATIONS

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Figure 6.5, Staf Suaveillance Statistics (Page 5)
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Figure 6.5, Clar SULVEILLANCE STATISTICS (PAGE 7) HUNTER LIGHT SCRUAFIN 1 CARDINS

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IDENTIFICATION RANGE (METERS) MEAN Standard deviation	119.72? 3.669	c c	900
IDENTIFICATION TIME (CAVS.HFS.MINS) MFAN STANDAR) DEVIATION	333567 37456 1881	000000	0. JUJE 0. JUJE

Figure o.E. Tide volution statistics (page 17)
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AURAL DEFECTION STATISTICS OF THE TARGETS BY STAF

TAPGET NUMBER	-1	<	m	•	•	•
NUMBER OF DETECTIONS	L î	£	c	c	•	•
DETECTION SUCCESS HATED	1.00	1.07.1	ن• ن	0.0	1.000	0.0
DETECTION GANGE (METERS) MEAN STANDARD DEVIATION	3-4.1P1	240.831	د ن ن د	0 f	311.82¢	\$ C
DETECTION TIME (DAYS, MES, MINS) MEAN STANDARD DEVIATION	15151°	12270	900000	000000	05122	600000

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	AURAL DETECTION STATISTICS OF THE TARGETS BY STAF
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TAP GET NUMBER	NUMBER OF DETECTIONS	PETECTION SUCCESS RATED	DETECTION RANGE (METERS) MEAN Standago deviation	DETECTION TIME (DAYS, MRS, WINS) MEAN STANDARD DEVIATION	TAFGET LOCATION STATISTICS	TARGET NUMBER	TARGET LOCATION CEP (METERS) Mean Standaru deviatien

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TAP SET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METERS) MEAN STANDARD DEVLATION	DETECTION TIME (DAYS, HPS, MINS) .MEAN STANDARD DEVIATION	TARGET LOCATION STATISTICS	TARGET NUMBER	TARGET LUCATION CEP (METERS) MEAN STANDARD DEVINTION

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THE TARGETS BY STAF	U · •→	U	9 • 6	0.0	330000	6	000
AND STATISTICS OF THE TAR	TARGET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METERS) Mean Standard Deviation	DETECTION TIME (DAYS, HRS, MINS) MEAN. STANDARD DEVIATION	TARGET LUCATION STATISTICS TARGET NUMBER	TARGET LOGATION CEP (METERS) Mean Standard deviation

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AUDITORE STATISTICS (PACE 11)
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TARGET LOCATION CEP INFTERS)
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TARGET LOCATION STATISTICS TARGET NUMBER

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Floure 6.5, SIAF SURVEILLANCE STATISTICS (PAGE 15)

AURAL DETECTION STATISTICS OF THE TA	OF THE TANGETS BY SIAF	51 AF				
TARGET NUMBER	3	. 32	33	*	38	
NUMBER_OF DETECTIONS	•	•	•	•	•	
DETECTION SUCCESS RATIO	3.8°C	0.0	0.0	9.0	1.000	
DETECTION RANGE (METERS) MEAN STANDARD DEVIATION	27.909 3.0	0 0	60	00	301.201	263.412
DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	00000¢	000000	000000	000000	0.0000	

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Pigure con sive conveillance ofatistics (pass 16)
Honter Liggett scenario (

AURAL DETECTION STATISTICS OF THE TAPGETS BY STAF

TARGET NUMBER	37	•	39	0	7	?	
NUMBER OF DETECTIONS	ت	O	c	c	•		
DETECTION SUCCESS RATIO	c.	0.0	J.C	0.0	0.0	1.002	
DETECTION RANGE (METERS) MFAN Standard deviation	0.0	00	0 C	00	00	369.338	;
DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	000000 000000	000000	000000	000000	000000	000000	1
TARGET LOCATION STATISTICS		•	• • • • •				1
	37	35	39	9	7	3	ŧ
TARGET LOCATION CEP (METFRS) Mean Standard deviation	(U 0 0	19.649	000	۵° د و	• o	37-125	•

Figure 6.5, Staf Strivellinge statistics (PAGE 17)
HUNTEP LIGGETT SCENARIO 1
5 REPLICATIONS

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	*	•	1.000	470.139	000000		**	4e.114 0.112
	9	•	1.000	466.798	000000		*	46.161
	\$\$	•	1.000	394.064	000000		· \$\$	46.151
I AF	;	0	0.0	.0	000000		*	192.413
THE TARGETS BY STAF	. 5	•	1.000	374.015	000000	• • • • • • • • • • • • • • • • • • •	*	36.810
AURAL DETECTION STATISTICS OF THE T	TARGET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METERS) MEAN STANDARD DEVIATION	DETECTION TIME (DAYS, HRS, MINS)	TARGET LOCATION STATISTICS	TARGET NUMBER	TARGET LOCATION CEP (METERS) Mean Standard Deviation

Figure 5.5, STAF SUPVEILLANCE STATISTICS (PACE 18)
HUNTER LIGGETT SCENARI3 1
5 REPLICATIONS

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ARGETS BY S	•	ပ	0.0	0 n	030000
HIRAL DETECTION STATISTICS OF THE TARGETS BY STAF	TARGET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METEPS) MEAN STANDARD DEVIATION	DETECTION TIME (DAYS,HRS,MINS) MEAN Standard deviation

TARGET LOCATION STATISTICS

. 15	105.904
\$	105.001
\$	17.214
TAPGET NUMBER	TARGET LOCATION CEP (METERS) Mean Standard Deviation

Figure 6.5, Tauget Sugveticlance Statistics (Page 19)
Hunter Liggett Scenario 1
5 Replications

UNAIDED VISUAL DETECTION STATISTICS OF STAF BY THE TARGETS

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NUMBER OF DETECTIONS	•	•	•		•	•
DETECTION SUCCESS RATIO	0.0	0.0	0.0	0.209	0.	. 6
DETECTION RANGE (METERS) MEAN STANDARD DEVIATION	 		0.0	172.478	00	000
DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	000000	000000	000000	115020	000000	900000
DETECTION CUES AURAL SENSOR	٠ .	•	•		0	0
IDENTIFICATION STATISTICS OF STAF BY	THE TARGETS					
TARGET NUMBER		~	•	•	•	•
NUMBER OF IDENTIFICATIONS	ن	c	0	• • •	•	
IDENTIFICATION SUCCESS RATIO	0.0	0.0	; 0°0	0.0		9
IDENTIFICATION RANGE INETERS) MEAN STANDARD DEVIATION	٠. د د د	6 5	0.0	90	•	
VS.HRS.HIN	181		3	2		16905 Page
STANDARD DEVIATION	03 0000	000000	000000	000000	000000	20

Figure 5.0, Targer SURVEILLANCE STATISTICS (PAGE 20)
HUNTER LIGGETT SCENARIO 1
5 REPLICATIONS

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TARGET NUMBER	_	•	•	13	=======================================	12
NUMBER OF DETECTIONS	د	c	0	•	0	
DETECTION SUCCESS RATIO	J.C	٥.٢	0.0	0.0		00000
DETECTION RANGE (METERS) MEAN STANDARD DEVIATION	00	60	c c .	00	00	1036.898
DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	000000	000000	000000	000000	000000	030000
DETECTION-CUES AURAL SENSOR	ပ	¢,	c	0		•
DENTIFICATION STATISTICS OF SIAF BY	BY THE TARGETS	5.		: 1		
TARGET NUMBER	~	•	•	9	=	~
NUMBER OF IDENTIFICATIONS	ပ	0	•	•	•	

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OF STAF BY THE TARGETS	-	Č	0.0	9°	399965 599965 599665
DENTIFICATION STATISTICS OF SIAF R	TARGET NUMBER	NUMBER OF IDENTIFICATIONS	IDENTIFICATION SUCCESS RATIO	IDENTIFICATION RANGE (MFTERS) MEAN Standard Deviation	INFNTIFICATION TIME (DAYS,HRS,MINS) MEAN STANDARD DEVIATION

Figure S. S. Tako, Novelltanos utatistics (page 21) HUNTER LIGGETT SCRNAGIO 1 5 REPLICATIONS

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TARGET NUMBER	. 61	* 1	15	91	17	
NUMBER OF DETECTIONS	o	c	~	c	c	•
DETECTION SUCCESS RATIO	J.C	د• د	0.493	C.0	0.0	0.603
DETECTION RANGF (METERS) Mean Standard deviation	000	0.0	1037.792	. c.	00	30.502
DETECTION TIME (DAYS,HRS,MINS) MEAN Standard Deviation	330003	000000	031734	000000	#00000 000000	032203
DETECTION CUES TARGET AURAL SENSOR	O	c	c	c	c	;

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UNALUED VISUAL DETECTION STATISTICS OF STAF BY THE TARGETS	F SIAF 9V	THE TARGETS				
TARGET NUMBER	61	02	21	22	23	
NUMBER OF DETECTIONS	0	•	6	c	~	
DETECTION SUCCESS PATIO	0 • 0	0.600	3. c	0.0	9.400	0.0
DETECTION RANGE (METERS) MEAN STANDARD DEVIATION	0.0 0.0	40.622	0 C	90	38.592 0.963	00
DETECTION TIME (DAYS,HRS,MINS) MEAN STANDARD DEVIATION	030000 930009	95009Cu	000000	000000	000000	00000
DETECTION CUES AURAL SENSOR	ပ	c	6	6	•	i

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	*2	C	0.0	60	000000
	23	~	1.000	38.502 0.963	743306 907000
	22	•	J.C	c.c.	(00000
	12	•	0.0	oc 00	000000
	22	•	1.333	33.466	232040
F STAF BY THE TARGETS	61) . SNO	RATIO 9.C	METERS) 0.0 N 0.0	AYS,HRS,MINS) Octore Octore
IDENTIFICATION STATISTICS OF	TARGET NUMBER	NUMBER OF IDENTIFICATIONS	INENTIFICATION SUCCESS	IUFNTIFICATION RANGF (METERS) Mean Standard deviation	IDENTIFICATION TIME IDAYS, MRS, MINS) MEAN STANDARD DEVIATION

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UNALUES VISUAL DETECTION STATISTICS OF STAF 67 THE TAPAETS

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1 AP GET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METERS) Mean Standard deviation	DETECTION TIME (DAYS,HRS,WINS) MEAN Standard deviation	DETECTION CUFS AURAL Sensor	IDENTIFICATION STATISTICS OF STAF BY	TARGET NUMBER	NUMBER OF IDENTIFICATIONS	IDENTIFICATION SUCCESS RATIO	IDENTIFICATION RANGE (WETERS) MEAN STANDARD DEVIATION	IDFWIIFICATION TIME (DAYS,HRS,M Mean Standard Dfviation

Figure 6.5, TARGET SURVEILLANCE STATISTICS (PAGE 24)
HUNTER LIGGETT SCENARIO 1
5 REPLICATIONS

UNAIDED VISUAL DETECTION STATISTICS OF SIAF BY THE TAPGETS

TARGET NUMBER	31	32	6	*		46
NUMBER OF DETECTIONS	~	0	•	0	E	
DETECTION SUCCESS RATIO	0.25	0.0	0.0	0.0	0.0	
DETECTION RANGE (METERS) Mean Standard deviation	25.087 3.0).0).0	00	00	, 00 00	000
DETECTION TIME (DAYS, HRS, MINS) - MEAN STANDARD DEVIATION	020000	000000	303000	000000	000000	000000
TION GUE AURAL SENSOR	•	o	• .	, 0	•	0
IDENTIFICATION STATISTICS OF SIAF BY	THE TARGETS	· · · · · · · · · · · · · · · · · · ·	• • • • •			i i
TARGET NUMBER	TE	32	33	Ř	W	• • • • • • • • • • • • • • • • • • •
NUMBER OF IDENTIFICATIONS	-	c	0		٠.	
IDENTIFICATION SUCCESS PATIO	1.066	0.0	0.0	0.0	0.0	0.0
IDFNTIFICATION RANGE (MFTERS) MEAN Standard Deviation	25.087	00 00	00	0 c	000	Pa
IDENTIFICATION TIME (DAYS, HRS, MINS)	NS) C50054	000000	900Ju	320309		905-60 ge 6-1

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STANDARD DEVIATION

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Figure 6.5, TAPSET SURVEILLANCE STATISTICS (PAGE 25)
HUNTER LIGGETT SCENAPI 1
5 REPLICATIONS

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TARGET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE IMETEPS! MEAN STANDARD DEVIATION	DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	DETECTION CUES AURAL Sensor	IDENTIFICATION STATISTICS OF STAF BY	TARGET NUMBER	NUMBER OF IDENTIFICATIONS	IDENTIFICATION SUCCESS RATIC	IDENTIFICATION RANGE (METERS) Mean Standard Deviation	IDENTIFICATION TIMF (DAYS,HRS,M) Mean Standard deviation

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Figure 6.5, TARGET SURVEILLANCE STATISTICS (PAGE 26)
HUNTEP LIGGETT SCENARIO 1
5 REPLICATIONS

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UNAIDED VISUAL DETECTION STATISTICS OF STAF BY THE TABGETS	
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TARGET NUMBER	- NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METERS) MEAN STANDARD_DEVIATION	DETECTION TIME (DAYS, HRS, MINS)		- 1 DETECTION CUES	SENSOR		LOENTIFICATION STATESTICS OF STAF. BY	TARGET NUMBER	NUMBER OF IDENTIFICATIONS	IDENTIFICATION SUCCESS RATIO	IDENT	STANDARD DEVIATION	ATION TIME LOAYS, HRS.	MEAN STANDARD DEVIATION

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Figure 6.5, FAFSET SURVEILLANCE ST. STICS (PAGE 27) HUNTER LIGGETT SCENARIO 1 5 REPLICATIONS

UNAIDED VISUAL DETECTION STATISTICS OF STAF BY THE TARGETS

TARGET NUMBER	. 64		16	,
NUMBER OF DETECTIONS	•	5	•	
DETECTION SUCCESS RATIO	1.000	1.01	1.000	
DETECTION RANGE (METERS) MEAN STANDARD DEVIATION	119.722	736.548	736.548	
DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	900000	270643 000000	010643	
DETECTION CUES AURAL SENSOR	င	c	•	

IDENTIFICATION. STATISTICS OF STAF BY THE TARGETS	THE TAPGE	15	
TARGET NUMBER	6	Ċ	2
NUMBER OF IDENTIFICATIONS	•	c	•
IDENTIFICATION SUCCESS RATIO	1.00.0	0.0	0.0
IDENTIFICATION RANGE (METERS) Mean Standard deviation	119.722	°°°	00
IDENTIFICATION TIME (DAYS,HRS,MINS) MEAN STANDARD DEVIATION OO	MINS) 0764C 0000C0	0000C0 000000	00000 00000

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Figure 6.5, TARGET SHRVETLLANCE STATISTICS (PAGE 23)
HUNTER LIGGETT SCENARIO 1
5 REPLICATIONS

AUPAL DETECTION STATISTICS OF STAF BY THE TARGETS

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	c	0		0°0 0°0		000000
TARGET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METERS)	MEAN Standard Deviation	DETECTION TIME (DAYS, HRS, MINS)	STANDARD DEVLATION

MUNTER LIGGETT SCENARIO 1 5 REPLICATIONS AURAL DETECTION STATISTICS OF STAF RV THE TARGETS	TT SCENARIO 1 CATIONS	
HUNN AURAL DETECTION STATISTICS OF STAF BY THE	TER LIGGE 5 REPLI	TARGETS
AURAL DETECTION STATISTICS OF STAF BY	Z .	THE
AURAL DETECTION STATISTICS OF STAF		E
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	•	0.	0.0		000000
•	0	0.0	9 c	000000	00000
TARGET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS PATIO	DETECTION RANGE (METERS) Mean Standard deviation	DETECTION TIME IDAYS, HRS, MINS) MEAN	STANDARD DEVIATION

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AURAL DETECTION STATISTICS OF STAF AY THE TARGETS

TARGET NUMBER	13	.	51	91	17	2
NUMBER OF DETECTIONS	ن	•	c.	c	•	0
DETECTION SUCCESS RATIO	0.0	0.0	0	c.0	0.0	0.0
DETECTION RANGE (METERS) Mean Standaru deviation	٥٠٠ ٥٠).).	c c	0 0	0.0	00
DETECTION TIME (DAYS, HYS, MINS) MEAN STANDARD DEVLATION	0 10000	000000	000000	000000	000000	000000

Figure 6.5, Takoni Survelliande Staffsfils (Pase 31)
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22	0	0.0	000	000000
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TAPTET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS MATED	DETECTION RANGE (WETERS) MEAN STANDARY DEVIATION	DETECTION TIME (DAYS,MPS,MINS) MEAN STANDAPD DEVIATION

Figure 6.5, TARGET SURVEILLANCE STATISTICS (PAGE 32)
HUNTER LIGGETT SCENARIO 1
5 REPLICATIONS

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TARGET NUMBER	52	92 .	12	28	53	30
NUMBER OF DETECTIONS	c	o	c	0	•	•
DETECTION SUCCESS RATIO	J.n	3.0	ن • ي	£ .	٥.5	0.0
DETECTION RANGE (METFRS) Mean Standard deviation	0.0 0.0	0.0	60	00	° ° °	• • •
DETECTION TIME (DAYS,HRS,4INS) MEAN STANDARD DEVIATION	000000	000000	000000	000000	000000	000000

Figure 6.5, TARGET SURVEILLANCE STATISTICS (PAGE 33)
HUNTER LIGGETT SCENAPIO 1
5 REPLICATIONS

AURAL DETECTION STATISTICS OF STAF BY THE TARGETS

TARGET NUMBER	31	. 32	33	*	35	*
NUMBER OF DETECTIONS	•	0	•	•	•	•
DETECTION SUCCESS RATIO	0.0	9.0	0.0	0.0	0.0	0.0
DETECTION GANGE (METERS) MEAN STANDARD DEVIATION	0 c	000	00	00	00	••
DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	000000	000000	000000	000000	000000	000000

Figure 6.5, TARGET SURVEILLANCE STATISTICS (PAGE 34)

	1 KG	S AEPLICATIONS				
AURAL DETECTION STATISTICS OF SIAF BY THE TAPGETS	Y THE TAPO	ETS				
TARGET NUMBER	37	. 36	36	9	7	,
NUMBER OF DETECTIONS	•	•	•	•	•	
DETECTION SUCCESS RATIO	0.0	0.0	0.0	J.C	6.9	0.0
DETECTION RANGE (METERS) MEAN STANDARD DEVIATION	0.0	0.0	0.0	0.0	٠. ن	0
TOTAL SALE SALE SALE SALES	•	•	5	•	G•0	•
STANDARD DEVIATION	300000	000000	000000	00000	000000	9000

igure 6.5, TARGET SURVEILLANCE STATISTICS (PAGE 35)

AUMAL DETECTION STATISTICS OF STAF BY THE TARGETS

TARGET NUMBER			45	•	*	‡
NUMBER OF DETECTIONS	c	c	c	•	•	•
DETECTION SUCCESS RATIO	0.0	0.0	0.0	0.0	0.0	0.0
DETECTION RANGE (METERS) Mean	0.0	0.0	• •	0.0	ು 0	' O
STANDARD DEVIATION	٥.0	e•0	0.0	0.0	••	0.0
DETECTION TIME (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	000000 000000	000000	000000	000000	000000	000000

Figure Cost Tabuel Stavelliance Staffstiffs (Page 3a)
Printed Libbett Scenario 1
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TANGET NUMBER	0	٤	15
NUMBER OF DETECTIONS	ŭ	c	c
DETECTION SUCCESS PATIO	9°C	1.1	0.0
DFTECTION RANGE (METERS)	٥.	0.0	Ċ
STANDARD DEVIATION	0.0	0.0	C .
DETECTION TIME (DAYS, HRS, MINS) MEAN			
STANDARD DEVIATION	20000	000000	00000C

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(P45£	
ACALLA CONTRACTOR CONT	
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9.744 1/3.037 105.030 14.467 42.942 0.0 90.254 7.0 0.0 72.917 55.666 0.0 3.0 7.3 6.2 7.813 0.0 0.0 3.0 7.3 6.2 7.813 0.0 0.0 8CEN11 1 2 3 4 5 9.366 100.001 100.000 14.000 42.520 0.0 3.941 7.0 7.0 7.0 7.0 7.0 70.000 7.392 100.000 3.941 7.0 7.0 0.0 4.000 7.39 0.0 0.0	CAUSES OF A CORTECTION FOR STAF (PERCENT)
1.73.037 105.030 16.667 42.942 3.7 0.0 72.917 55.666 3.3 0.0 2.604 1.392 100.001 100.000 16.000 42.520 3.1 5.0 10.000 2.362 3.0 0.0 6.0 6.0 6.0	
3.7 0.0 72.917 55.666 3.3 C.2 7.813 0.0 3.0 A.6 2.604 1.392 100.001 100.001 100.001 42.520 3.3 A. \$ \$ 100.001 100.001 42.520 55.118 3.3 C.0 100.001 2.362 3.0 O.0 4.000 C.3	•
3.3 C.2 7.813 0.0 3.0 A.6 2.604 1.392 100.00.3 100.00 10.5220 3.3 4 5 100.00 100.00 42.520 3.3 7.7 70.00 55.118 3.3 C.0 100.00 2.362 3.0 O.0 4.00 C.3	6
3.0 0.6 2.604 1.392 2 3 4 5 100.001 100.000 16.000 42.520 3.0 0.0 10.000 53.118 3.0 0.0 4.000 2.362	• •
100.001) 100.000 14.000 42.520 7.7 7.6 70.000 55.11# 7.1 2.0 10.000 2.362	c
100.001) 100.000 14.000 42.520 7.7 7.6 70.000 55.11# 7.1 5.9 10.001 2.362	TARGETS (PERCENT)
100.001) 100.000 16.000 42.520 7.7 7.6 70.000 55.118 7.7 6.0 10.000 2.362	
3.3 7.0 7.0 70.000 55.11A 3.3 5.9 10.000 2.362 3.9 0.0 6.0 6.9	ř
3.3 C.0 10.00n 2.362 3.0 C.0 6.0n C.0	A5.
3.0 0.0 6.0 C.D	ř
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CAUSES OF NO DETECTION FOR STAF LIREQUARY

MASKING BY RELIEF			•				•
173.300 40.434 0.0 33.384 3.0 59.596 0.0 64.350 5.0 0.0 0.0 1.937 3.0 0.0 0.0 1.259 13.300 40.404 0.0 33.384 0.0 59.596 3.0 64.350 0.1 0.0 6.0 0.0 0.0		^	o n	•	01		13
3.0 59.596 0.0 64.350 5.0 0.0 0.0 1.057 0.0 0.0 0.0 1.259 103.000 40.404 0.0 33.384 0.0 59.596 0.0 64.350 0.0 0.0 0.0 0.0		19.032	150,300	909°U9	0.0	33,384	17.978
6.0 0.0 1.007 3.0 0.0 0.0 1.259 103.000 40.404 0.0 33.384 3.0 59.596 3.0 64.350 0.0 0.0 0.0 0.0 0.0		93,968	2.0	56.596	ن	64.350	69.169
3.0 0.0 0.0 1.259 103.000 40.404 0.0 33.384 3.0 59.596 3.0 64.350 0.0 0.0 0.0 0.0 0.0		Ů.0	6.0	0.0	0.0	1.937	0.562
9 9 10 103.000 40.404 0.0 33.384 0.0 59.596 3.0 64.350 0.0 0.0 0.0 0.0		0.0	0.0	0.0	a.o	1.259	16.292
11 13.000 40.404 0.0 33.384 3.7 59.596 3.0 64.350 0.7 n.0 100.000 2.266	RGETS IPE	RCENTI					
103.000 40.404 0.0 33.384 0.0 59.596 0.0 64.350 0.0 0.0 0.0 0.0		•	œ	•	2	-=	į
0.7 59.596 3.0 64.350 5		19.032	103.000	40.404	0.0	33.384	
0.1 n.0 100.000 2.266 n.0 c.0 0.0 0.0		99.968	0.0	965.65	9.0	64.350	65.409
0.0 0.0 0.0			(°0)	o• c	100.000	2.266	5.682
		0.0	0.0	0.0	0.0	0.0	10.227

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Figure 6.5, STAF/TABGET SUPVFILLANCE STATISTICS (PAGE 39)
HUNTEF LIGGETT SCENARIO 1
5 REPLICATIONS

7.3

CAUSES OF NO DETECTION FOR STAF (PFRCENT)

						1	:			!
	61.431	36.392	1.009	1.089		=	61.335	36.335	1.087	1.242
11	78.750	21.250	6.0	6.0		1.1	74.110	20.000	200.5	6.0
91	0°0	0.0	0.0	0.0		16	0.0	0.0	0.0	c.
15	14.167	199.99	2.500	16.647		21	14.054	66.116	4.959	14.876
*	33.969	63.262	0.0	2.769		*	33.969	63.262	5.769	0.0
13	0.0	د ق	° 0	· • c	TARGETS (PERCENT)	13	0.0	0.0	0.0	0.0
TARGET NUMBER	MASKING BY RELIEF	MASKING BY VEGETATION	PANGE AND LIGHT LEVEL	INSUFFICIENT TIME	CAUSES OF NO DETECTION FOR TARGETS (PERCENT)	TARGET NUMBER	MASKING BY RELIEF	MASKING BY VEGETATION	RANGE AND LIGHT LEVEL	INSUFFICIENT TIME

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Figure 6.5, STAF/PARSET SURVETLLANCE STATISTICS (PAGE 43)
HUNTEP LIGGETT SCENARIO I
5 REPLICATIONS

CAUSES OF NO DETECTION FOR STAF (PERCENT)

TARGET NUMBER		61		•		ř	! !
MASKING BY RELIFF		•	2	17	22	23	*2
		D*c	52.195	0.0	0.0	90.238	
MASKING BY VEGETATION		100.001	40.373	0,0			16.576
RANGE AND LIGHT LEVEL		0.0	6		0 0	0.0	74.305
INSUFFICIENT TIME		0		3	0.0	0.0	0.0
CAUSES OF NO DETECTION FOR TARGETS (PERCENT)	TARGETS	(PERCENT)	26846	0.0	100.000	9.722	7.119
TARGET NUMBER	!	6	,	,		!	•
MASKING BY RELIEF.			0.7	77	55	23	*
		D•0	53.125	0.0	0.0	-89.041-	
TASKING BY VEGETATION		90.196	40.625	0.0	0.0		
RANGE AND LIGHT LEVEL		3.8.6	: #	!		0.0	74.222
INSUFFICIENT TIME			621.6	0.0	100.000	0.0	4-111
		0	3.125	0.0	0.0	10.060	

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Figure 6.5, STAF/TARGET SURVEILLANCE STATISTICS (PAGE 41)
HUNTEP LIGGETT SCRNARIO 1

TARGET NUMBER TARGET NUMBER TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER TARGET NUMBER CAUSES OF NO DETECTION FOR TARGETS (PERCENT) TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.722 TARGET NUMBER MASKING BV VEGETATION TI.723 TARGET NUMBER MASKING BV VEGETATION TI.723 TARGET NUMBER MASKING BV VEGETATION TI.723 TARGET NUMBER TARGET NUMBER MASKING BV VEGETATION TI.723 TARGET NUMBER TARGET NUMBE		HUNTEP LI	HUNTEP LIGGETT SCENARIO 1 S REPLICATIONS	1 014				
23.136 46.154 35.444 37.122 0.0 18.1 71.722 27.473 59.355 50.204 9C.933 18.1 0.0 0.0 0.0 2.332 27.2 5.141 26.374 5.161 12.265 6.736 36.3 7ARGETS (PERCENT) 25 26 27 27 27 28 28 409 53.801 44.557 91.645 18.1 71.722 28.409 53.801 44.557 91.645 18.1 6.449 0.0 14.035 22.279 2.390 27.3 6.469 0.0 14.035 22.279 6.800 38.3		(PERCENT)				!	:	,
23.136	TARGET NUMBER	25	92 .	7.2	2.0	2		
71.722 27.473 59.355 50.204 9C.933 9.0 0.0 0.0 2.332 5.141 26.374 5.161 12.265 6.736 7ARGETS (PERCENT) 25 26 27 27 28 29 71.722 28.409 53.801 44.557 91.645 4.499 0.0 14.035 22.279 2.350 6.60	MASKING BY RELIEF	23.136	46.154	35.444	37.122	0.0	18.102	
5.141 26.374 5.161 12.265 6.736 TARGETS (PERCENT) 23.136 47.727 32.164 32.946 C.0 71.722 28.409 53.801 44.557 91.645 4.499 0.0 14.035 22.279 2.350 6.603 23.964 C.0 0.218 6.00	MASKING BY VEGETATION	11.722	27.473	59.355	\$0.204	90.933	16.162	
5.141 26.374 5.161 12.265 6.736 7ARGETS (PERCENT) 23.136 47.727 32.164 32.946 6.0 71.722 28.409 53.801 44.557 91.645 4.499 0.0 14.035 22.279 2.350 6.60 0.218 6.00	RANGE AND LIGHT LEVEL	0.0	e. C	0.0	9.409	2.332	27.273	
7ARGETS (PERCENT) 25 26 27 28 29 23.136 47.727 32.164 32.946 6.0 71.722 28.409 53.801 44.557 91.645 4.499 0.0 14.035 22.279 2.350 0.643 23.964 6.0 0.218 6.00	INSUFFICIENT TIME	5.141	26.374	191.5	12.265	6.736	36.364	
25 26 27 28 29 23.136 47.727 32.164 32.946 6.0 71.722 28.409 53.801 44.557 91.645 4.499 0.0 14.035 22.279 2.350 0.643 23.964 6.0 0.218 6.00		ETS (PERCENT)						
23.136 47.727 32.164 32.946 C.O 71.722 28.409 53.801 44.557 91.645 4.499 0.0 14.035 22.279 2.350	TAPGET NUMBER	25	56	12	58	2	2	
71.722 28.409 53.801 44.557 9 4.499 0.0 14.035 22.279 0.643 23.864 G.0 0.218	MASKING BY RELIEF	23.136	47.727	32.164	32.946		10-103	
4.499 0.0 14.035 22.279 0.643 23.864 G.0 0.218	MASKING BY VEGETATION	71.722	58.409	53.801	44.857	_	10.102	
0.643 23.964 G.O 0.21R	RANGE AND LIGHT LEVEL	664.4	0.0	14.035	22.279		27.273	
	INSUFFICIENT TIME	. 0.643	23.964	0.0	0.214	100-1	-36-76-	

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Figure 5.5, STAF/TARGET SURVEILLANCE STATISTICS (PAGE 42)
HUNTER LIGGETT SCENARIO 1
5 REPLICATIONS

CAUSES OF NO DETECTION FOR STAF (PERCENT)

	11.607	63.482	0.0	110.4		:	11-314	11.375	7.311	
	=	8	0	4			-	=		•
3.5	89.206	7.143	0.0	3.571		38		7.004	5.447	0.0
*	91.549	ວ•0	0.0	154.0		3.	929.85	0.0	0.0	-14.474
33	0.0	0.0	o•0	100.000		33	0.0	Ç.C	100.000	0.0
. 32	0.0	0.0	0.0	0.0		32	0.0	0.0	0.0	0.0
31	52.147	39.877	3.067	6.908	TS (PERCENT)	31	50.595	38.690	2.976	7.738
		NO	בר בר		OR TARGE	÷		NO	EL .	ı
TARGET NUMBER	MASKING BY RELIEF	MASKING BY VEGETATION	RANGE AND LIGHT LEVEL	INSUFFICIENT TINE	CAUSES OF NO DETECTION FOR TARGET	TARGET NUMBER	MASKING BY RELIEF	MASKING BY VEGETATION	RANGE AND LIGHT LEVEL	INSUFFICIENT TIME

Figure 6.5, STAF/TARSET SURVEILLANCE STATISTICS (PAGE 43) HUNTER LIGGETT SCENAPIO 1

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TARGETS (PERCENT)
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100.001
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Figure 5.5, Staf/TawjeT SLOVEILLANCE STATISTICS (PAGE 44)
HJNTEP LIGGETT SCENARIO 1
5 REPLICATIONS

CAUSES OF NO DETECTION FOR STAF (PERCENT)

•	100.000	0.0	0.0	0.0		•	46.394	0.0	0.0	1.606
•	100.001	0.0	6.5	6.0		41	98.000	0.0	2.000	0.0
9	103.000	0.0	0.0	٥.		9	000°86	٥٠٥	2.000	٥•ر
\$\$	100.000	٥.٠	0.0	0.0		\$	98.000	ن• ن	٥.0	2.090
;	0.0	C.0	6	3.0		*	0.0	0.0	100.903	0.0
63	54.875	3.124	0.0	J.r.	TARGETS (PEPCENT)	£\$	95,473	3.112	0.0	0.415
TARGET NUMBER	MASKING RY RELIEF	MASKING AY VESETATION	RANGE AND LIGHT LEVEL	INSUFFICIENT TIME	CAUSES OF NO DETECTION FOR	TAPGET NUMBER	MASKING BY RELIEF	MASKING BY VEGETATION	PANGE AND LIGHT LEVEL	INSUFFICIENT TIME

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可在一个人们的人们们的现在分词,我们会找了了一种的人们,我们们不是有人就可以说:"你们们	of Contraction Contraction of the Park 1	Control of Control of
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TAS SET NUMBER	,,	.	15
MASKING BY PELIEF	3.0	<u>;</u>	0.0
MASKING BY VESETATION	•	•	.7
FANCE AND LIBME LEVEL	٠•٢	?	43.333
INSURFICIENT TIME	t, • t`	0.0	15.047
AUSES OF NO DETECTION FOR TAPOETS (PERCENT)	ETS (PEGGENT)		
TABGET NUMBER	5 7	\$	15
MASKING BY RELIFF	υ. •	٠.٢	0.0
MASKING BY VESFTATION		· · ·	(
PANGE AND LIGHT LEVEL	J*C	C•0	0.6
	,	0.0	0.0

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C.964	C71033	220°6	
MOVEMENT RATE (KMZHA) Mean Standard deviation	PATROL DURATION (DAYS, HRS, MINS) MEAN STANDARD DEVIATION	DISTANCE TRAVELLED (KM) Mfan Standard deviation	MOVEMENT RATE HISTOGRAM (KM/HR)

MOVEMENT RATE HISTOGRAM (KM/HR)	SIH	TOGRAM (*	(4/HB)					
PERCENT	TIME	BETWEEN 0.7		1	0.2C0 K4/HR	K#/HR	H).no4
PERCENT	TIME	RFTWEEN	0.273		J.460	K#/HR	*	0.0
PERCFUT	1146	BETHEEN	3.477 -		0.660	K#/HP		606°د
PERCENT	TIME	BETWEEN	0.600 -		0.8nC	K#/HR		3.318
PERCENT	TIME	BETWEEN	- 008.0		1.000	an/wx		1.457
PERCENT	TIME	BETWEEN 1.330 -	1.730		1.266	KM/HR		100.0
PERCENT	TIME	BETWEEN 1.200 -	1.20ñ		1.400	KM/HR		3.038
PEACENT	TIME	BETWEEN 1.400 - 1.600	1.400		1.600	KM/HR	H	0.137
PERCENT	TIME	BETHEFN 1.506 - 1.8CC	1.536		1•AC	A 1 / 12		3.004
PERCENT	TIME	RETWEEN	1.803 -		2.005	KM/HR		0€0°¢
PERCENT TIME	TIME	BETWEEN 2.000 -	2.27		2.2CO KM/HR	KM/HR		3.002
PEACENT	TIME	PERCENT TIME RETWEEN 2.239 - 2.4FF KM/HR	2.239		2.400	KW/HR	*	101.6

Figury 5.5, Staf Navidation Statisfics (Page 47)
POINTER LIGGETT SCHUARIO 1
5 REPLICATIONS

PATROL CEP AT CHECKPFINTS (METERS)

31.621

STANDARD DEVIATION

TIME TO DETERMINE LOCATION (MIN) MEAN

STANDARD DEVIATION

0.830 0.0

SIAF INSERTION STATISTICS

INSERTION ATTEMPTS

NUMBER OF INSERTIONS AT PRIMARY L2

NUMBER OF SUCCESSFUL INSERTIONS

NUMBER OF INSERTIONS AT SEC. LZS

011100 INSERTION TIME (DAYS, HRS, MINS)

EXTERNAL COMMUNICATIONS

	-1	
		DEVIATION
ATTEMPTS	MEAN	STANDARD

COMMUNICATION SUCCESS RATIO STANDARD DEVIATION

AVERAGE POWER LOSSES FOR COMMO FAILURES (PERCENT)
ATTENUATION DUE TO VEGETATION 1.019
ATTENUATION DUE TO VEGETATION 1.019
ATTENUATION DUE TO RANGE 88.037 C.827 0.034

000000 TOTAL TIME RECIEVING IDAYS, HRS, MINS) STANDARD DEVLATION

-IDTAL TINE TRANSMITTING (DAYS, HRS, MIAS)
MEAN
STANDARD DEVIATION
OCCOLD

STANDARD DEVIATION AMPERE HRS AVAILABLE AMPERE HRS USED MEAN

79.817 C.093

138.903

76.030 0.0

SW3	000°0	0 0 0 0	000	00	2-250
SYLWINGS	65.053 0.0	0.0 0.0	8.017 0.0	00	3-250 0-0
SUPPLY MAINTENANCE STATIFFEE	TOTAL WEIGHT CARRIED LURS/MAND MEAN STANDARD DEVLATION	FUOD (LBS/MAN) MEAN STANDARD DEVIATION	WATER (LRS/MAN) MEAN STANDARD DEVIATION	AMMO (LBS/MAN) MEAN STANDARD DEVIATION	OTHER ORDNANCE (LAS/MAN) MEAN STANDARD DEVIATION

	.•	. `•	• •	300°C) C	6 6 6 6
ENESCY EXPENSE (ATD) MEAN STANDARD DEVIATION	non	(u • ù	684°;	4131,103 33,000	0.0 0.0	1318.49C 6.13Q
THIRD ST AR	TIME ALSTORY OF AUMAN OF CONMINCE OF GRADITION (FIRST REPLICATION ONLY)	O GEAUST	08 (5 [RS] 80	PLECATION ONE		
TIME PERF. DEG.	211772	012072 (+010	012303	020231	020532 0.002	050000
TIME PERF. DEG.	3-15-0 0-16-0	C21531 C.0	021931	022132		

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Prof. of Commission assault

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	574115	7561¿0 C1	16 032030	000000	92	94	04	94	00000u	000000 #\$	90 0000
-	E	2 66 165	15	210000	27 000000	5000C0	96 68	000000 48	00000	57 57 57	63
18Y5.41.	17.11.	420 TZC	627 (E)	20	26.30°	35	300030	000010	56 242 201	969000 96	000CJJ
TAN TO ARE STATE OF THE STATE O	ין בני אברני	7 212310	*	0.000.0	2.5 3306.13	18 00000	263630	66,0000	49	5.5 6C 2C00	000000 000000
	CLUTKPOINT APPLICAL TILE	ANIOWNIAL DESCRIPTIONS	CHECKPGINT ALRIVAL TIME	CHECKPOINT APRIVAL TIME	CHFOKPOINT APRIVAL TIME	CHECKPOINT Applyal Time	CHECKPOINT ARRIVAL TIME	CHECKPOINT ARRIVAL TIME	CHECKPOINT ARRIVAL TIME	CHECKPOINT ARRIVAL TIME	CHECKPUINT ARRIVAL TIME

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56 - 335 FG	94 900.300	80	746130	92 C70643
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CHECKPOINT APRIVAL TIME	CHECKPOINT ARRIVAL TIME	CHECKPOINT ARRIVAL TIME	CHECKPOINT ARRIVAL TIME	CHECKPOINT ARIVAL TIME

LIGHT LEVEL (FT LAMPERTS) AND SAMPLE TIME (DAYS, HRS, MINS)

						_
1.00E-93 012000	1.00E-03	6.92E-04 020500	1.00E 04 021190	1.726 93	1.00E-93	1.006-33
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Table 6-1, Target Number System (Sheet 1)

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EVENT	
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- TRUCK (ROUND TRIP) - MEN + WATER CANS - LIT CIGARETTES

AMMO CARRIERS - DAY 02

1 - MEN

STAR CLUSTER EVENT - DAY 02

5 - TRUCK (ROUND TRIP) 6 - FLARE (COLUMN)

TRUCK/AMMO EVENT - DAY 03

7 - TRUCK + TAILGATE BANGING 8 - LIT CIGARETTES

SMOKE AT SUNRISE EVENT - DAY 03

9 - MEN 10 - SMOKE COLUMN

RADAR ANTENNA ASSEMBLY - DAY 03 11 - TRUCK (ROUND TRIP) 12 - MEN 13 - CIGARETTE SHOKE (COLUMN)

RADAR ANTENNA DISASSBABLY - DAY 03

15 - MEN 16 - CIGARETTE SHOKE (COLUMN) 14 - TRUCK (ROUND TRIP)

SECURITY PATROL (A-LOOPS) - DAY 03 17 - TRUCK (DELIVERY) 18 - PATROL THROUGH LOOPS

19 - TRUCK (DELIVERY)
20 - PATROL THROUGH LOOPS (C-TRAIL)
21 - TWO PATROLS LEAVING
AGGRESSOR TENT
22 - LIT CIGARETTE HODOLE CARRIERS - DAY 04

49 - TRUCK (ONE-WAY) 50 - PATROL 51 - CIGARETTE SMOKE (COLUMN)

STAR CLUSTER EVENT - DAY 05

36 - TRUCK (ROUND TRIP) 37 - FLARE

Jabis 6-1, Target Turbering byster (Sheet 2)

. HELIPAD EVENT - DAY 06	38 - TRUCK (ROUND TRIP)	40 - STROBE LIGHT 41 - LANDING LIGHTS	PASSING TRUCKS - DAY 06	43 - RADAR DISASSEMBLY TRUCK	LASER EXERCISE - DAY 06	DA COLUMN AC VAC - SYCIET SWISS BO	45 - RADAR ASSEMBLY TRUCK	46 - LOOP PATROL TRUCK 47 - MODDLE CARRIER TRUCK	48 - TWO TRUCKS FOR PICK-UP	ROAD PATROL EVENT - DAY 07
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EXOTIC MENPON EVENTS 124-04	25 - TRUCK (DELIVERY) 26 - PATROL	SECURITY PATROL (A-LOOPS) - DAY 04	27 - TRUCK (DELIVERY) 29 - PATROL (A-1 TO A-41)	WATER CAN EVENT - DAY 04	28 - TRUCK (ROUND TRIP)	NOODLE CARRIERS - DAY 05	31 - PATROL (C-LOOPS) 32 - TWO PATROLS LEAVING	AGGRESSOR TENT 33 - LIT CIGARETTE	34 - CROM'S NEST PATROL 35 - TWO TRUCKS (PICK-UP)	TO THE PROPERTY OF THE PROPERT
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* EVENTS PLANNED FOR A SECOND PATROL IN THE TEST, THAT PRESENT DETECTION OPPORTUNITIES FOR THE FIRST PATROL.

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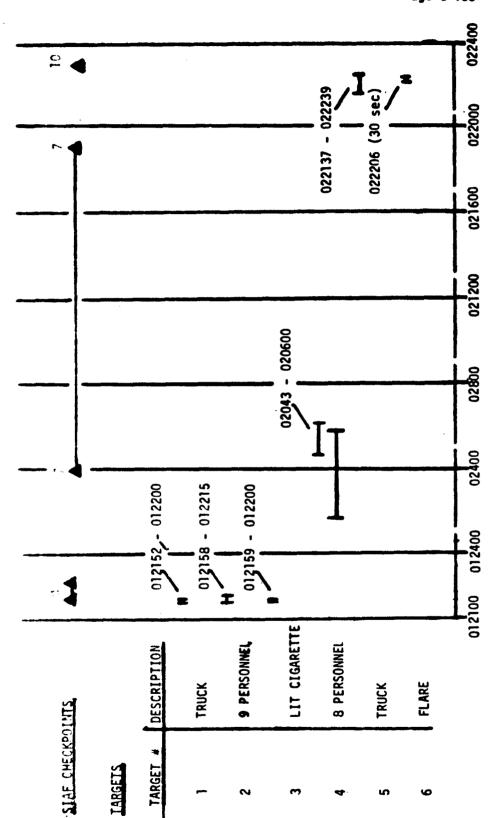


Figure 6.7, Timeline Diagram for Selected Portion of the Scenario

6.5 USER INPUT FOR THE COMBAT MODEL SAMPLE CASE

As an example of the operation of the integrated reconnaissance and combat model including the additions made in the modification contract, the following case is presented. Figure 6.8 shows the namelist input used for this case. The area of operations is taken from the Hunter Liggett Military Reservation. The scenario calls for a SIAF patrol of eight men on an ambush mission. They are moving in the dry El Piojo Creek bed at 0800. The scenario is diagrammed in Figure 6.9. The target starts on the other side of an 80 foot hill approximately 600 meters away. The target is a six-man patrol and is heading on a collision course with the SIAF.

6.6 OUTPUTS FOR THE COMBAT MODEL SAMPLE CASE

The outputs of the model, shown in Figure 6.10, consist of detail and summary printout. The detailed printout begins with the location of the target and of the SIAF. Two lines of printout are generated by the Reconnaissance model at the end of each segment. This gives the positions, a detection verdict, the time, and the reason for no line of sight.

At 17 minutes into the mission, the SIAF detects the target. This is shown by point 1 on Figure 6.9. It is in an area of both vegetation and microrelief. The output then shows the generation of a dynamic route to seek recognition of the target. The grid plot shows the selected grid points for the dynamic route. One minute later, the SIAF identifies the target. The range is 264 meters. This is shown by point 2 on Figure 6.9 for both the SIAF and target. At this point, a dynamic route is generated to return to the original route should that be the decision of the SIAF.

The action selected by the decision logic submodel is to continue to ambush. A preliminary deployment point and engagement point is selected which is the first admissable point. The optimization logic then selects deployment points for both a base of fire and a moving maneuver unit. These are shown by the pair of points labelled number 3 at the edge of the wooded area. The projected engagement point for the target is also shown. The optimization logic also determines an assault point close to the target.

At this point in the simulation, the terrain resolution is shifted from 50.8 meters to 12.7 meters for greater accuracy in the line of sight calculations. The individual attributes are then printed for both patrols

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at the start of combat. The next computation is the generation of dynamic routes for the attacker maneuver units to the deployment points.

The combat model through its executive routine, CMAIN, then assumes control of the simulation. This is driven by the first occurrence of a detection, arrival at the checkpoint (generated by dynamic route routine), casualty, or 20 seconds if nothing else happens. For other missions, it considers also the arrival of an external fire support burst and the detonation of Claymore mines. For this case, the first few events are individual detections by SIAF members of target members. More detections could be occurring, but only one is printed per patrol at each event interval. Here the locations of the maneuver unit leaders are also printed. The next two events are arrivals at the intermediate dynamic route points. This process continues until both maneuver units have arrived at their deployment points. At this time, they stop. A dynamic route is generated for the moving maneuver unit to get to the assault point, but movement does not begin on this leg for an ambush until the firefight has begun. The model continues to print detection events for the attacker of the defender while the defender is moving to the engagement point.

When the defender arrives at the engagement point, the SIAF opens fire and a casualty event occurs within 2 seconds. As shown in the print-out, the casualty is defender number 5 who sustains a minor wound. The next event is another casualty. This time defender 2 sustains a major wound. The elapsed time of the firefight is 3.3 seconds. The attribute tables for both patrols are then printed as they are after either a major wound or death. At this time, the defender decides to withdraw and selects a direction 180° opposite to which it was moving. The break decision was due to the high number of casualties.

At the five second point, defender number 3 is killed. The break decision printout is repeated for information purposes, but no new action is taken. The next eventis a major wound for defender 1 at 6.2 seconds. At 7.8 seconds, defender 6 is killed and at 9.7 seconds, defender 4 is killed. At this point all defenders have been killed or wounded. The SIAF stops firing and the moving maneuver unit reaches the first checkpoint on its assault route.

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At 30 seconds, however, the SIAF decides to break due to an elapsed time criterion. A rally point is selected on the opposite side of the hill and the SIAF begins moving. After arriving at the rally point, the patrol decides to continue the reconnaissance mission. The final attributes are printed and control is returned to the Reconnaissance Model. At this time, the elevation data at the 50.8 meter resolution is retrieved. The SIAF then completes its operations plan and is extracted. Summary statistics for the mission are then printed.

6.7 EXAMPLE USING EXTERNAL FIRE SUPPORT

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The same case was run using external fire support in preparation for the firefight. The same inputs were used except the mission was changed to attack. The same deployment and engagement points were selected, but this time a volley of artillery shells arrived soon after the request. Figure 6.12 shows the detailed output from there on. First the burst points are printed and then the attributes after the burst. The next event is a casualty inflicted by the SIAF who open fire after the first volley. The next events are arrivals of more volleys of artillery. Again the target decides to break in the opposite direction. The attacker decides to break due to the elapsed time criterion.

6.8 EXAMPLE USING CLAYMORE MINES

For this case, the mission was switched to an ambush using Claymore mines. As shown in Figure 6.13, the mines were deployed just inside the edge of the wooded area. The SIAF was deployed in the woods and was not detected by the target. When the target reached the most vulnerable area with respect to the mines, they were detonated and all of the target personnel were killed. Control then returned to the Reconnaissance model after the withdrawal. The detailed output is shown in Figure 6.14.

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Figure 6.8. Combat Sample Case Namelist Inputs

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20660-6002-RO-00 Page 6-151 Revised December 1973 100 METERS Sample Case Diagram Finure 6.9, 120

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Figure 6.10, Sample Case Output

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\$ 1 AF IS TO BE THE SUBJECT PATPOL

DEPLOYMENT PUBLIX

ENGAGERENT POINT X = 11077, 1943

FOR MARCUVER UNIT NURSER 1. ULUMIC CUMPUTES APPRUACH PATH

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FIRE TEAM MUMBER		•		***	•			-	c
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NEXT X (METER)	၁ ဂ•၀	0.00	0.0	00.0	3.33	3.00	20.0	3.00	3.00
NEXT Y (METEL)	0.00	00.0	3	3.10	3.03	3.0	00.0	20.0	0.00
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- EI⊴	STATISTICS ON ABOVE DYNAMIC KOUTE NUMBER OF POINTS IN THE PLUTE:		DYNAMIC ACUTE EN	K.V COGAUINATES ON EACH MOVEMENT FIR THE LEAGER OF THIS MU.	STATISTICS ON ARCVE OVNAMIC FOUTE

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ROUNDS REPAIN CHARLE		-4	~	~	3		THEODE	NOAMAL		
FUNCTICA IN PATROL	•	7	17	7	2 .	٧:		~	c	
MOVEMENT FATE (MICEOL)) ه ا ک	A.F. L.	R IFLE MAN	F. GUNNER	Call NC to	11	~	11		
INDIV. ASSIGNMENT		\$3.	80. 0			MENTAL	KIFL EMAN	RIFL PAN		
INITIAL AMAG SUPPLY	Da Se Pris.	1120 ·	BASE FR.	BASE	BASE FR.	00.00 04.66	45.	÷5.	0.00	
WEAPON TYPE	001	001	(C)	100	-62	2	- CM.	N. UNIT	· :	
POSIT. IN FIRE TEAM	1	4 Y	ABEA	APEA	AREA	AREA	001	001	S	
SECONDARY WEAPON AVE	H. (% : 3	H. CACAL	A Cuen		•	'n	4 7 ×	4 × ×	•	
NO. OF PARC CARREN	•	•		r. GKEN.	M. GREN.	H. GREN.	H. GREN.	N. GREN.		
HOTELS LANGE LOOPING	~	~	, c	•	*	*	•	,	•	
) j	7	r	•		•		

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* · · ×	14-4	74- XA	10111	14-14	10.11	•	•	•
7 5 7.7	0001 141 141 141 141	103 DFA:	, 3	CALLED IN	3:9	· • •	,	> i
12.50	TON	NCT	¥.1	NOT	Ş			
C	C	8	•	•	•	•	÷	0
6	1072.18	1076.05	1364.68	1361.18	10.11.01	0.0	. •	0.00
7	10801	1636.05	1597.75	1662.14	1093. 55	9	0.00	0.00
000	00.0	8.0	0.00	9.0	3.3	0.0	•	0.00
3	0,00	0.30	0.00	3.00	8.0	00.0		00.0
0/	1.70	1.70	1.70	1.73	1.70	00.0	•	0.00
e,	. 50	.53	04.	. 50	3.	0.00	0.00	0.00
CNC	PKONE	PRONE	STANC	STAND	STAND			
2.0	STOPPED	STOPPED	70.	10P SP.	TOP SP.	(•	•
		 .	-	-	-	0	0	0
~	20	2		2	2,	0	ာ	•
•	A.V.L.	PIFLE MAN	HIFL EMAN	ALFL-11 E	*IFLERAN			
7	. 30	.33	• 30	. 30	3.	0.0	000	0000
	BASE FR.	BASE FR.	BASE FR.	JASE FR.	BASE FR.			
0	100	3	201	3	8	0	9	0
4	AN EA	A A GA	ARRA	AR FA	AREA	1	:	
		•	•		•	0	a	
ن ک	SUC.	NON.	37.07	7	SAC.			,
7	9	7	r	C	3	ດ	ب ا	0
C			•	0	0	0	0	•

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RREAM DECISION & DEFFICIE FERRIS CONTACT GOT TO HIGH CASUALTY FRACTION POSITION OF ATTACKS OUT A 1170-SE Y- 1654-68
POSITION OF ATTACKS OUT A 1177-0- Y- 1662-74
POSITION OF ATTACKS OUT A 1177-0- Y- 1662-74

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CANDELTY VEXT

DEFENCE PARTY OF FAILS THE CANDELTY

THE MISH OF THE CANDELTY NEWFORD IS: 1

THE TYPE F CANDALTY SE CALL ADDRES

TIMETSECT THAT CHANT INTO SELECT MAN BEEN UNITERABLE

PROSITION : A - 1173-00 N - 1003-03

6.1454

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ATTREBUTY TASLE AFTER CASE	Jar I Y	SUSTALMED	•			1	•	•	•
ATTACKER PATHOL:		7	PATAIN	A NE ABER	.	6	•	23 . i	•
FIRE TEAM NIVER		~	-	-		~	~	-	•
MEAPON TYPE	4-10154	V-16(SA)	145 141-M	H-16(A)	3 24	H-16(5A)	H-10 (SA)	145) 91-H	•
CURRENT AME SLPPLY	96	?	8	60	~	<i>\$</i>	2	8	3
CASUAL TY STATUS	ວ ຂ)¥	3	Ş	3	3	₹		
FIRING STATUS	PUINT	POINT	PUINT	POINT	POINT	POINT	POINT	12104	
SUPPRESSION STATE	0	0	O	C	•	•	•	?	•
CURRENT X (METER)	11 77.04	1170.62	1176.36	1117.57	1175.73	1170.16	1160.54	1172.22	00.0
CURRENT Y (METER)	1662.74	1663.60	1678.44	1647.50	1674.72	1692.39	1654.60	166 9.31	00.0
MEXT X (METHO)	1177.19	1150.54	1176.73	1177.67	1176.22	1:74.16	1158.23	115 67	0.00
	1682.44	1665.45	1677.46	1647.41	1672.40	1692.39	1661.24	1670.00	0.00
	1.70	1.70	1.70	1.73	1.70	1.70	1.70	1.73	00.0
	G.	. 50	.50	.50	. 50	8.	• \$0	.50	0.00
IT PC	STAND	STAND	STAM	STANO	STAND	STARD	STAND	STAND	
MOVING STATUS	STUPPED	PICK WAL	STUPPEU	STOPPED	STUPPEU	STOPPED	MURMAL	MORPAL	
RANEUVER UNIT	~		~	~	~	~	-	-	0
ROUNDS REMAIN ("AG.)	16	91	9.		91	2	91	91	3
FUNCTION IN PATRUL	}	A.P.L.	X IFLEMAN	T. CLENER	CR.LNCH.	RIFLEMAN	RIFLEHAN	AIFL EMAN	
MCVENENT RATE (M/SEC)	00.0	. 54	S	00.0	8.0	8	•\$•	•5•	0.00
	BASE FR.	H. CAIT	BASE FR.	SASE FR.	BASE FR.	MASE FR.	TIND .	M. UNIT	
INITIAL APMO SUPULY	130	001	3	100	•	8	801	001	0
MEAPON TYPE	4 9 % A	ASEA	AREA	AFFA	AREA	AP EA	AREA	AREA	
POSIT. IN FIRE TEAM			7	m	*	S	~	~	0
SECONDARY WEAPON AVI	H. CANA	H. CREN.	I CPEN	F. CKEN.	H. GREN.	H. CAEM.	T. CEEN.	H. GREN.	
	4	4	*	•	*	•	•	•	9
NG.OF SHINE GPENADE	~	7	C	9	9	0	O.	?	0

DEFENDED STANTS	•	-	4 Ta 4	TO MERKEY 10		•	•	1	3
	-	•	n	•	•	•	•	Þ	•
FIRE TEAM NETTER	í.	:		4	••		~	0	0
MEAPON TYPE	14-41	147	74-AA	AK-47	AK-47	14-4L			
CURRENT APMU SUPPLY	7	3.	(÷1	7	3	1 33	n	c	n
CASUAL TY STATUS	JAN. B. LAN.	CAL CH. AV	(T) i	C)Po	Chotia. 14	?		•	
FIRING STATUS	トラア	177.	NCT	Trica	¥.C. =	17			
SUPPRESSION STATE	د.	^	7	2	C	c	?	O	C
CURRENT X (V'TE')	1174.52	1072.16	1374.05	1363.37	10MJ. 87	1371.50	2.00	00.0	0000
CANTON Y INTRACTOR	1040,70	10%.14	16de - 34	1697.50	1641.89	1043.00	0.00	70.0	3.00
NEXT X CAPTURE	0.00	00.0	0.00	0.00	00.0	3°30	00.0	0.03	00.0
	J. C. C.	٥٠٠٠	0.00	0000	ار در		00.0		0.33
HEIGHT (4: TEX)		1.17	1.73	1.70	1.73	1.73	00.0	0.00	0.00
(Vilus) FLORE	0.00	Oc.	35.	.53	. 5.	.50	00.0	1.33	0.0
CURRENT POSTURE	W. F.	PHUNE	サスにん	STAND	STANU	STAND		 	
NOVING STATUS	STUPPEL	A TOPPED	STOPPED	TOP SP.	TOP SP.	TCP SP.			
MANEUVER CRIT		-		-			0	0	0
ROUNDS REMAIN (MAG.)	0	0,	20	18	07	2	0	0	0
FUNCTION IN PATABL	P.1.	4.P.L.	A IFLE MAN	HIFLEMAN	RIFLEMAN	KIFLEMAN			
MOVEMENT RATE (M/S EC)	9.30	. 30	.30	.30	0.30	S	00.0	2.00	0.0
INDIV. ASSIGNMENT	BASE F4.	BASE FR.	BASE FR.	BASE FR.	BASE FR.	BASE FR.	: } !		İ
INITIAL AMMI SLPPLY		1 00	8	100	8	3	0	၁	0
MEAPON TYPE	∢	AREA	AREA	AREA	AR EA	AP EA		1	1
POSIT. IN FIRE T- AM	!	2	-	•	\$	0	0	0	3
SECONDARY MEAPON AVI	1. XOZ	NON	NUN	NONE	FOOR	NON			
	0	0	9	0	0	0	0	0	0
NO. OF SMOKE GRENAUS	O	6	0	0	2	0	0	0	0

HETAKS CONTACT DUE TE LACK OF AGRUDATE FINEPCHEP A BONE 4 FO BREAK OLCISION :

PREAK DETISION: 1 DEFENDED PREAKS CONTACT DUE TO HIGH CASUALTY FRACTION POSITION OF ATTHOMS OF A 1104-97 TO 1663-81 POSITION OF ATTHOMS OF A 1177-00 TO 1663-81 POSITION OF ATTHOMS OF A 1177-00 TO 1663-74 POSITION OF ATTHOMS OF A 127-00 TO 1663-76

Page 6-175 Novised December 1973

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T. TITT DEFENDER PAINT SUSTING THE NEXT LASUALTY
THE NUMBER OF THE CASUALTY RETHER IS 1 O
THE TYPE IN CLOUDTY IS LELTH
TIMESED THAT LICHAR LESS BEEN UNDERNAVE
POSITION 1 X - 1134-97 to 165-81

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FIRE TEAM NUMBER OF THE TOTAL TOTAL MOTORS AND MOTORS A	ATTACHES PARMIT:			1-11-1	4 2 2 4					
11		•	~	•	•	<i>(</i> ,	&	•	7	.
127.34 P-101541 M-10141 M-10141 M-10141 M-101541	FIRE TEAM NUMPER							-	-	0
17 19 19 19 19 19 19 19	MEAPIN TYPE	187 - 1	[48]0[-4	(85) 57 - W	M-10141		M-: 615A1	4-14(34)	V-1c (SA)	
177-34 120-47 1170-35 1177-57 1175-72 1170-15 1171-20 1171-20 1177-57 1170-15 1170-15 1171-20 1177-57 1170-15 1170-15 1171-20 1177-57 1170-15 1170-15 1171-20 1171-20 1177-57 1170-15 1170-15 1171-20 1171-20 1177-57 1170-15 1170-15 1171-20 1171-20 1177-57 1170-15 1170-1	CUPRENT ANNO SUFFLY		÷	÷	45		\$5	ç	ď,	د:
1177-34 PUINT POIN	CASUALTY STATUS) ·	?	7	Ž	ż	2	Ž	?	
1177.34 1120.497 1170.45 1177.57 1175.72 1178.10 1164.73 1171.40 15.57.34 1661.43 1177.43 1177.57 1175.72 1178.10 11061.73 1171.40 15.57.34 1661.43 1176.73 1177.40 1177.57 1170.52 1170.43 1556.43 1556.43 1576.43 1176.73 1177.57 1170.52 1170.52 1170.53 1556.43 1556.43 1556.43 1576.43 1576.44 1667.49 1377.44 15	FIPING STATUS	I To Table	IN I CA	12100	INION	TA Tero	Pulnt	POLINE	PUINT	
1177.34 1160.73 1177.57 1175.73 1170.15 1160.73 1171.50 15 15.5.34 160.73 1171.50 15 15.5.34 160.73 1171.50 15 15.5.34 160.73 1171.50 15 1171.50 15 1171.50 15 1171.50 15 1171.50 15 1171.50 15 1171.50 15 1170.22 1170.22 1170.23 150.13.23 155.5.30 155.5.30 15.7.4	SUPPRESSION STATE	•	0	2	0	7	7	3	C	3
177.14 1661.41 1672.44 1587.76 1172.22 1176.15 1156.20 1154.61 1156.20 1157	CUSSELT X 185154)	1171.	1160.91	1176.55	1177.57	1175.72	1178.15	1164.73	1171.36	0.00
117.14 1150.54 1170.75 1170.22 1170.15 1150.20 1150.25 1170.24 1570.45 1570.	CURRENT Y INCTEX	10001	1661.41	167: 44	156 7.70	1014.7	1092.39	1528.63	losd.	0°0
1-70 1.70 1.70 1.70 1.70 1.70 1.70 1.70 1.	TURKE X TANK	:1111:	11:0.54	1170.70	1:17.01	11.70.24	11 76.15	1156.20	115+007	0.00
1.70 1.70 1.70 1.70 1.70 1.70 1.70 1.70	Ī	1-52.64	1 160- 45	1077.44	1597.041	10/2.48	1592.39	1061.24	167 3.65	00.0
-50 -50 -50 -50 -50 -50 -50 -50 -50 -50	_	1.70	70	1.13	1.70	1.73	1.70	1.70	1.70	00.3
STAND STUDPED NUMBER NUMBER 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	_	D.	. 53	04.	.53	. 50	.50	05.	.50	0.00
TIPPED NOWAL STUPPED STOPPED NUMBEL NUMBEL 1	CURRENT PRISTURE	PARTO	STAND	STAND	STAND	STAND	STAN	STAND	S F A.W.	!
15 15 15 15 15 15 15 15 15 15 15 15 15 1	HOVING STATUS	Judd.115	TYN MON	STUPPED	Stupped	Cindi, 18	STOPPED	AUT PAL	NUNDAL	!
15 15 15 15 15 15 15 15 15 15 15 15 15 1	MANECVER UNIT			~	~	~	~	-	~	•
BASE FA. M. UNIT BASE FR. BASE FR. BASE FR. W. UNIT M.	ROUNDS HEMAIN (MAG.)		51	2	S	5	7	51	51	0
3.30 .54 0.00 0.30 0.03 0.00 .54 .54 .54 .54 .54 .54 .54 .54 .54 .54	FUNCTION IN PATRICE	,	A.P.L.	PIFLEPAN	P.GUNNER	Ch.LACH.	AIFLEMAN	PIFLE WAN	A 1 F	
HASE FM. M. JUIT BASE FW. RASE FW. BASE FW. W. UNIT M. UNIT 100 100 100 100 100 100 100 100 100 ANY AREA AREA AREA AREA AREA AREA AREA ARE	MOVEMENT HATE (M/S CC)	00.0	95.	00.0	00.0	9.6	00.00	*C.	•\$•	00°0
130 100 100 100 100 0 100 100 100 100 10	INDIN ASSIGNMENT		N. UVIT	BASE FP.	NASE FX.	BASE FR.		F. UNIT	A. CAIT	
AND AREA AREA AREA AREA AREA AREA AREA ARE	INITIAL APMIN SUPPLY	201	001	001	1001	. • i	31	100	COI	7
P. GREW. H. GREW. H. GREW. H. GREW. H. GREW. H. GREW. H. G. H. L. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4.	MEAPON TVFF	Ant A	AKEA	AREA	AREA	AREA	AREA	AKFA	4KCA	
F. GREY. H. GREN. H. GREN. F. GREN. W. OFEN. H. GREN. N. GREN. A. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4.	POSIT. IN FIVE TEAM	-	-	~	~			~	m	0
NO.0F FAUD JAFNADE 4 4 4 4 4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0	SECCHDARY WEAPON AVE	r. Gard.		٠.	T. GREN.	,		_	H. GAEN.	
NO.OF SMOKE GPENANE 2 2 0 0 0 0 0 0 0	NO.OF TAND SKENADE	•	•	•	•	4	•	•	•	•
	NO.OF SMUKE GPENAUF	~	~	0	9	つ	0	?	0	9

DEFENCEP PATGL:		?	PATEC	ABRASN 13	`A	. .	¹ ~~	.10	,	
	' -			;	!-		.			
MEAPON TYPE	AK 7	AK-47	AK -47	VK-47	AK- 7	AK-47	1	,	•	
CHRRENT AND SUPPLY	50	001	01	7	3	8	•	O I) 3	
CASUAL TY STATUS	PA . BUILL	MA. BUIND	UEAL	3	MI-WOUND	Oc 40				
FIRING STATUS	T. 2	▶ □▶	10.	3	FC:	SCT	•	•	•	
SUPPRESSION STATE	9	0	0	•				2		
CORREST X CALIFICA	1374.62	1072.10	1678.95	100.00	74.090	1071-12	20.0			
CURRENT V (45 * E.A.)	1644.70	-1 - 8 - 1 -	10.00	1697.21	1541. %	1007. K	00.0	00.0		
,	1. C. C	.0° .0°	3.	0.03	8	8	0	200	0500	
1011101 A 1101	0000	00.00	70.0	0.00	0.00	8	°.0	00.0	9.0	
	1.70	1.70	1.70	1.73	1.13	2.1	00.0	2.03	0.00	
	000	20	.50	.50	. 5.0	3	000	9	2.00	
CURRENT POSTURE	PRONE	P JAE	101	STAND	STAND	_				
MOVEMS STATUS	STOPPED	STOPPED	STOPPED	10P SP.	100 50.	STOPPED	•	•	•	
MANEUVE UNIT		-	- 7				0	0	· ·	
ROUNDS REMAIN (450.)		07	2	=	ر ک	2	•	0	•	
FUNCTION IN PATRICE	P.L.	A.P.L.	R IFLEMAN	RIFL ENAN	FIFLEMAN	PIFLEMAN			•	
MOVENEAT HATE (#/5 -C.)	0.50	. 30	2	35	.	2	90.0	200	201	
INDIV. ASSIGNMENT	HASE FR.	BASE FR.	DASE FR.	BASE FR.	BASE FR.	HASE FR.		•	•	
INITIAL APMO SUPPLY	007	8	3	001	8	8	•	>	•	
MEAPON TYPE	•	ALEA	APEA	ABEA	AREA	VALV	:		•	
POSIT. IN FIRE TEAS	· -	~		•		•	9	•	9	
SECONDARY NEAPCY AND	1/U.1	S. INE	₽ CNF	P.G.	ピンファ		•	•	•	
NO.OF PASE CHENAUE	O.	0	o .	0	۰ ا	0.1	>× :	> <	3	
NO.OF SMIKE GREITUE	•	0	•	•	•	•	•	•	•	

BREAK DECISION : UTFONDER BUTEKS CONTACT FUE TO LACK OF AUGUSTE FIREPOWER

BREAK UFCISION & LOTERNITH EXHANS CHNTACT BUE TO HIGH CASUMLTY PRACTICAL POSITION OF ATTACKS AND 12 PHONOS YN 1668-97
POSITION OF ATTACKS OF A 1277-35 FF 1652-74
POSITION OF ATTACKS OF A 1277-35 FF 1652-74

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9.6705 DEFENDING PATRIL SUSTAINS THE PEAT CASUALTY
THE NUMBER OF CASUALTY NUMBER IS A
THE TYPE OF CASUALTY IN THE TYPE OF CASUALTY
THEISELT THAT COMMATTEN HAS BEEN UNDERWAYS
PUSITION & X = 2104.40 V = 1065.57

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ATTACKÉH PATROL:	-	~	PATROL	L MENDER	.c.		7 7		•
	!			!				-	,
SE TEAM MUNICIPALITY		-		-	1	-	-	-	0
NEAPON TYPE	+10(SA)	F-16(5A)	M-161 SAJ	10191-11	3 24	M-16(5A)	1-10 (SA)	12311	•
CURRENT ANNO SUPPLY	**	\$	*	85	0	\$ {	* 3	•	•
WALTY STATUS	2	2	2	3	2			PART I	
PIRING STATUS	POINT	MION	PO INT	TMIOA					
SUPPRESSION STATE	0	•	0	0	•		9	0	
MENT K (METER)	1177.04	1164.8	1176.36	1177.57	1175.73	1176.16	1167.70	1170-33	3
CHORFAT V (METER)	1682.74	1663.97	1676.44	147.56	1674.72	1692. 3	1659.03		
MENT X LAFTED	1177.19	1120.54	1176.73	1177.67	1176.22	1176.15	1156.20	= .	0.0
	1042.44	1 465.95	1077.46	14.7.91	1672.40	16 92. 35	1661.24	1670.66	9.00
ME LOUT LAKTER!	1.70	1.70	1.70	1.70	1.10	1.2	1.70	<u>.</u>	3
	20	. 50	8.	.50	3.	3.	3.		
SENT POSTURE	STANC	STAND	ST AND	STAND	STAND	STAM	2740	STAND	
HOVING STATUS	STUPPLU	NOR HAL	STOPPED	STOPPED	ST000E	STOPE	MORNAL	MORMAL.	•
MANEUVER UNIT	~	-	~	~	~ (~		-:	•
HOS REPAIN (446.)	* _	* 1	*	~	9	2			>
PUBLICATION IN PATROL	4.1.	4.0.6.	A I PLEMEN	H.GUNNER	5.1%	RIFLEAM	MINTER !	MIN' CHAN	
MOVEMENT RATE (M/SEC)	00.0	•\$•	8.0	00.0	8	8	*		9
IV. ASSIGNMENT	BASE FR.	4. URIT	BASE FR.	BASE FR.	DASE FR.	BASE FR.	A. CRIT	5	Š
THITTAL AMED SUPPLY	000	001	3	00		8	_		•
MEADON TYPE	AKTA	AREA	AREA	AREA	AREA	AREA	AREA		
POSIT. IN FIRE TEAM					*		_!		
SECONDARY WEAPON AVI	H. CREV.	H. CKEN.	H. GREN.	F. GREN.	M. GREN.	H. GAEN.	H. GREN.	H. GREN.	ć
NO.OF FAND CRENADE	*	•	*	•	•	~ (•
	f)	^	0	8	•	ل -) -	-	

DEFENCER PATAPLE

THE TAKE NOTE:	••	-	•	•	•	• (•	>	•
BEAPON TYPE	DK-+ 7	K-17	K 17	VK 1.7	14-47				
CURRENT AMMO SUPPLY	76	001	3	96	8	8	9	0	0
CASUAL TV STATUS	A. NOUNC	44.40.140	DEAD	DEAD	OF COM . IM	0440			
FIRENC STATUS	T CN	10%	MOT	FOR	MOT	5			
UPPRESSION STATE	0	0	•	•	9	•	0	0	0
CUPRENT X (METER)	1374.62	1072.16	1074.05	106 7.56	1080.05	1071.12	00.0	00.0	0.00
CURRENT Y (PETER)	1689.70	16%.14	1686.04	1696.85	1641-23	1693.30	00.0	000	0.00
×	00.0	00.0	8.0	00.0	3		00.0	3.00	0.00
NEXT Y (METER)	00.0	00.0	8	00.0	8	į	00.0	00.0	00.0
-	1.70	1.70	1.73	1.70	1.70		0.00	00.0	•
IDTH (RETEK)	950	. 50	.50	.50	. 53		0.00	00.0	00.0
CURRENT POSTURE	TOPE	A ONE	78.08K	PAGE	STAND	1			
MOVING STATUS	STOPPEL	ST000E0	STUPPED	STOPPED	100 50.	\$10PPE0			
MANEUVER UNIT				-			0	•	•
ROUNDS REPAIN (MAG.)	<u>ح</u>	20	02	10	2	2	•	0	•
	P.1.	A.P.L.	A IFLE FAN	PIFL EMAN	RFLENA	1			
DVEMENT RATE (M/SEL)	30	. 30	8				8.	0.00	0.00
THOUY. ASSIGNMENT	BASE FR.	LASE FR.	BASE FR.	MSE A.	BASE FA.	BASE FA.			
THITTEL AMED SUPPLY	001	001	2	2		=	•	•	•
MEAPON TYPE	AME A	AREA	AREA	AREA		3			
DSIT. IN FIRE TEAM	-	2	•	*		•	•	0	•
SECONDARY MEAPON AVI	SON F	ACA.	NON	MONE	*0 *	3			
HO.OF HANC GRENAUE	•	0	•	•	•	•	•	•	•
	0	0	6			•		•	•

			ATTACKER MU I MILL MOVE 9.75 NETERS AT AN ANGLE OF	HETERS AT AN ANGLE OF
FIREFORER	ACT LON		ATLL MOVE 9:75	" . ILL MOVE 3.00
ENDER PREAKS CONTACT DUE TO LACK OF ADEQUATE FIREPONER	DEFENDER BRFAKS CONTACT DUE TO HIGH CASUALTY FRACTION PUL X- 1159-33 V- 1665-50		ATTACKER NO 1	ATTACKEN MU 2
S CONTACT DUE TO	S CONTACT DUE TC	5. V- 1682.74 5. V- 1689.70	1159-33 1665-53 FOVE MENT	
NEFENDER PREAKS	DE FENDER BRFAKS	. 4U 2 X- 1177.	1159.33 166	1117.04 102
BREAK DECISION : DEF	BREAK DECISION : DE POSITION OF ATTACKEP	POSITION OF ATTACKED POSITION OF DEFENDER	5+ PZ 8	1 8 2B C
	<u></u>	20	1_	

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ï÷ AN ANGLE OF 5 A. ANGL. IU 1 AILL MUVE19.36 VETERS AT IU 2 MILL MOVE19.30 VETERS AT 50.3 METERS AFTER CHANAT OFTRATES IS CLUMPETED BREAK DECISION : ATTACKER BREAKS CONTACT BUE TO ENCESSIVE ELAPSED TIMEIFIGHT) BREAK OECISION ? DEFENDER BPEAKS CONTACT DUE TO LACK OF ADEQUATE FIREPOREN BHEAKS CONTACT DUF TO LACK OF AULAUATE FIREPONE! ## DESTRICT OF ATTACKER WU I X- 1159.33 V- 1665.50

POSITION OF ATTACKER WU I X- 1159.33 V- 1665.50

POSITION OF ATTACKER WU I X- 1177.04 V- 1682.74

POSITION OF OFFENDER WU I X- 1074.62 V- 1689.70

POSITION OF DEFENDER WU I X- 1074.62 V- 1689.70 BREAK DECISION: DEFENDER BPFAKS CONTACT DUE TO MIGH CASUALTY FRACTION To for Break Contact-available Siaf Rally Point 1466, 2427 1626, 8864 ATTACKTR NU 1 ATTACKTE NU 2 TEVEL LF ţ TO SOLD SOUTH PERT IN THE FACTOR AND THE PROPERTY OF THE PROPE DECISION OF CONTIANTIAN FOR ACCOMMISSION CONTIANT WINSTON OF MAKERIAN COMPANY AND CONTIANT CONTIANT CONTIANT CONTIANT CONTIANT CONTIANT CONTIANT CONTIANT CONTINUES OF MAKERIANT CONTINUES OF CONTINUES WO EVENTS IN 20 SECUNDS. 14-11-55 10-28-73 PUNEMENT 1682.74 1626.49 POSITION OF ATTACKEN WU I X- 1180.43 Y- 1662.60 POSITION OF ATTACKEN WU \overline{z} $\overline{z$ 1626. 884 AND ACTUAL CHANGE OF A SACK ATTACKER WITHDRAVAL HOUT'S 1 + 6 5. 72 Ue F ENDER ATTACKER MITHORAWAL MOUTES • 7 7 BREAK OFCISION : 62 8 RESOLUTION

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PATEUL JUNATURE (LAYS) :

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PATRUL MEMBER

PATROL MEPUSR STATISTICS AFTER CUPBAT

ATTACKER PATRUL:

16154 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	. +
	H. CRE
	F H. GREN.
1007 1036- 10467 10467 10467 1067 1067 1067 1067 1067 1067 1067 10	
1 H-79 GL 2 0 0 1 H-79 GL 2 1 144 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	46
NOT NOT NOT NOT NOT NOT NOT NOT NOT NOT	*0
11 H-10(Sa) 24 MU MU MU MU MU MU MU MU MU MU MU MU MU M	+0
1 N-161SA1 94, NOT NOT NOT NOT NOT NOT NOT NOT NOT NOT	•
NO 1 1466.22 1626.89 1	2
MUMBER PER SUPPLY TATUS NO SUPPLY TOUS NO STATE (METER) (ME	SHOKE GRENADE
	NO. OF SHOKE

DEFENCER PATRCL:			1) X 1 4 L						
•		7		-	· •	•	_	•	•
FIRE TEAM NUMBER	1	1	1	7	-		0	0	0
MEAPON TYPE	AK-47	K-+2	14-44	CT XT	AK-47	14-47	•		
CURRENT ANNO SUPPLY	50	100	8	7	8	8	•	0	
CASUAL TV STATUS	MA. POUND	MA . MUUND	UEAD	0640	MJ-MOUND	3		•	
FIRING STATUS	13	404	101	TON	10%	25			
SUPPRESSION STATE	0	0	9	•	0		•	0	0
CURRENT K (METER)	1074.62	1072.16	1078.05	1067.36	1905.93	1071.12	8.0	00.0	9-00
CURRENT Y (METER)	1689.7	1096.14	1666.0	1696.15			0.00	8.0	0.00
	00.0	00.0	9.0	00.0	8	Ġ	8.	00.0	00.0
NEXT Y (METER)	000	0.00	9.0	0.00	8.0	8.0	00.0	00.0	00.0
	1.70	1.70	1.70	1.70	-	1.70	8.0	0.00	0.00
TIOIT (NETER)	.50	. 50	8	.50		3.	8.0	0.00	0.00
CURRENT PESTURE	PROME	PRONE	10 PE	PROME	STAND	MON			
MOVING STATUS	STOPPED	S TOP P ED	STUPPED	STOPPED	100 50.	STOPPEC			
MANEUVER UNIT	-		~		•		0	0	0
ROUNDS REMAIN IMAG. 1	61	20	20	=	20	2	0	0	•
FUNCTION IN PATROL	P.L.	A.P.L.	RIFLEPAN	PIFL EMAN	AIFLEMAN	Alflenan			
MOVEMENT RATE (M/S EC)	0:0		8.	.30	2.	2.	0.0	00.0	00.0
INDIV. ASSIGNMENT	MSE FR. IA	MSE FR.	BASE FR.	257	BASE FA.	DASE FR.			
INITIAL AMMO SUPPLY	100		8	2	8	2	•	•	0
HEAPON TYPE	ARE A	4	AREA	AREA	AA EA	AREA			
FOSIT. IN FIRE TEAM	-	2	7	•	•	•	0	0	0
SECONDARY MEAPON AVI	N.W.E.	202E	RCN.	#Che	AC AC				
NO.OF HAND GRENADE	0	0	0	•	•	0	0	0	0
THE CHANGE TO BUILDE			0	9		0		0	0

Best Available

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SIAF DETECTS TARGET NO. 1 VISUALLY SIAF PCSITUNS K = 1470.05 V = 1574.80 TARGET DETECTED: ND KTAR = 932 VTAR = 1576 LOS = 1 SIAF DETECTS TARGET NO. 1 VISUALLY SIAF DETECTS TARGET NO. 1 VISUALLY SIAF PCSITION: K = 1473.20 V = 1563.00 TARGET DETECTED: ND KTAR = 932 VTAR = 1576 LOS = 1	2 2	T T T T T T T T T T T T T T T T T T T	DAYS-01	HOUR S-09	TIME: DAYS-01 HOURS-09 MINUTES-03
	2	2	DAY 5-01	HOUR 5-09	1 1
	١				1
					†
XTAR = 932 YTAR = 1574.00 - 1524.00	CN	TIMES	10-3 Mg	10 S MICH	TIMES DAYS-01 MOMS-09 MINUTES-05
1500	9	TEME	DAY S-01	00-3 gr	TIMES DAYS-01 MOURS-AS MINISTER-AS

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												• •	•• •	•	•	•	• • •	!	uu.	2041 0041
	PLOT FUR STAP																		•	
!	TIPE MIVEMENT PLOT FIR STAF	2380 1	2020 1	1 0961	1 0061	0,01	1760 [1720 1	10991	1 00 91	1 0751	1 00 1		1360 1	1 0081	1 0421		11.20	10901	ctet • 1 cort

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SIAF SUAVE ILLANCE STATISTICS (PAGE 1)
HUNTER LIGGETT SCENARIO I
REPLICATIONS

TAT ISTICS OF THE TANGETS BY STAF	1	~	1.000	301.064	010 217	0	DF THE TARGETS BY SIMF	-	1.000	263, 878 0,000	010818 000000
UNAIDED VISUAL DETECTION STATISTICS	TARGET NUMBER	NUMBER OF DETECTIONS	DETECTION SUCCESS RATIO	DETECTION RANGE (METERS) MEAN STANDAND DEVIATION	DETECTION TIME LDAYS, MRS, MINS) NEAN STANDARD DEVIATION	DETECTION CUES AURAL SENSOR	IDENTIFICATION STATISTICS OF THE TA	TARGET NUMBER TANGET OF IDENTIFICATIONS		IDENTIFICATION RANGE (METERS) MEAN STANDARD DEVIATION	IDENTIFICATION TIME (DAYS, HAS, MINS) MEAN STANDARD DEVIATION 00

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STAF SURVE ILLANCE STATISTICS (PAGE &) HUNTER LIGGETT SCENARIO I 1 REPLICATIONS										
SURVE ILLANCE HUNTER LIGG	RGETS BY SIAF		•	0000	000.0	000 000		-	43.287	
SIAF	AURAL DETECTION STATISTICS OF THE TARGETS BY SIAF	TARGET NUMBER	AUMBER OF DETECTIONS	DEVECTION SUCCESS NATIO	DETECTION RANGE (METERS) FEAN STANDALD DEVIATION	DETECTION IT WE LOAVS . HKS . MINS) MEAN STANDARU DEVIATION	TARGET LOCATION STATISTICS	TARGET NUMBER	TARGET LOCATION CEP (METERS) MEAN STANDAKO DEVIATION	

STAFITARGET SUMVETLLANCE STATISTICS (PAGE 5) Hunten Liggett Scenaric i I Neplications

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SMS												
CALSES OF MODERNATION TO CALSES OF MEMBERS OF THE CATIONS	TARGET MILLER DE PLEN STAF (PERCENT)	The same of the sa	MASKING BY A FLIEF	MASKING BY VEGETATION 10.000	PANGE AND LIGHT LEVEL 0.000	CAUSES OF NO DETECTION FOR TARGETS (PERCFNT)	TARGET NUMBER	MASKING BY RELIEF 90.000	MASKING BY VEGETATION 10.000	RANGE ANE LIGHT LEVEL 0.000	INSUFFICIENT TIME 0.000	

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0.0.0

PCH CHAT TIME NETAFET 2.200 + 2.400 KPANP

4 39									•					!	
SIAF MUVEWENT STATISTICS (PAGE MINTER LIGGENT SCENARIO I REPLICATIONS	1.645	0109 C6 0109 C6 000 C6	1.356	1/HR1	3.000200 KM/HR - 0.000	.200400 KM/HR = 0.000	.+00 600 KM/HR = 0.000	.600600 KM/HR = 0.000	. 800 - 1.000 KM/HH = 0.000	306 - 1.260 KR/HR = 0.000	PERCENT TIME BETWEEN 1.200 - 1.400 KM/HR . 0.000	1.400 - 1.600 KM/MR = .595	THEN 1-600 - 1-800 KM/HH081	1.900 - 2.003 KM/HR = .323	CCC.C = EH/H3 CC ! - CCC -:
	PCVERENT RATE IKPING I MEAN STANDAND DEVIATION	PATRUL DURATION (DAYS, 149 S, 41NS) PEAN STANDAND DEVIATION	DISTANCE TRAVELLED (KM) MEAN STANJAND DEVIATION	POVENENT RATE HISTOGRAM (KN/HR)	PERCENT TIME BETWEEN 0.000	PENCENT TIME BETWEEN	PERCENT TIVE BETWEEN	PERCENT TINE BETWEEN	PERCENT TIAL BETWEEN	PERCENT TIME BETWEEN 1.300 - 1.200 KATHE	PERCENT TIME BETWEEN	PERCENT TIVE HETWEIN 1.400 - 1.600 KM/MR	PERCENT TIME BETWEEN	PERCENT TIME BETWEEN 1.800	FEACUAT II IN NATING N. 24, 200

									***************************************	•	
SIAF NAVIGATION STATISTICS (PALE 7) MUNTER LIGGETT SCENARIO I I REPLICATIONS	41.515	.7 50 0.000	SIAF INSERTION STATISTICS	7	The state of the s		•	0108 00		٠	
	PATP OL CEP AT CHECKP CINTS (METERS) PEAN STANDAND OF VIAT 10N	TIME TO DETERMINE LUCATION (MIN) MEAN STANDAND DEVIATION	18	INSFRION AFTEMPTS	NUMBER OF SUCCESSFUL INSERTIONS	NUMBER OF INSERTIONS AT PRIMARY LZ	NUMBER OF 145ERTIONS AT SEC. LZS	INSERTION TIME (DAYS, HRS, MINS)			

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STAF COMUNICATION STATISTICS (PAGE 4)

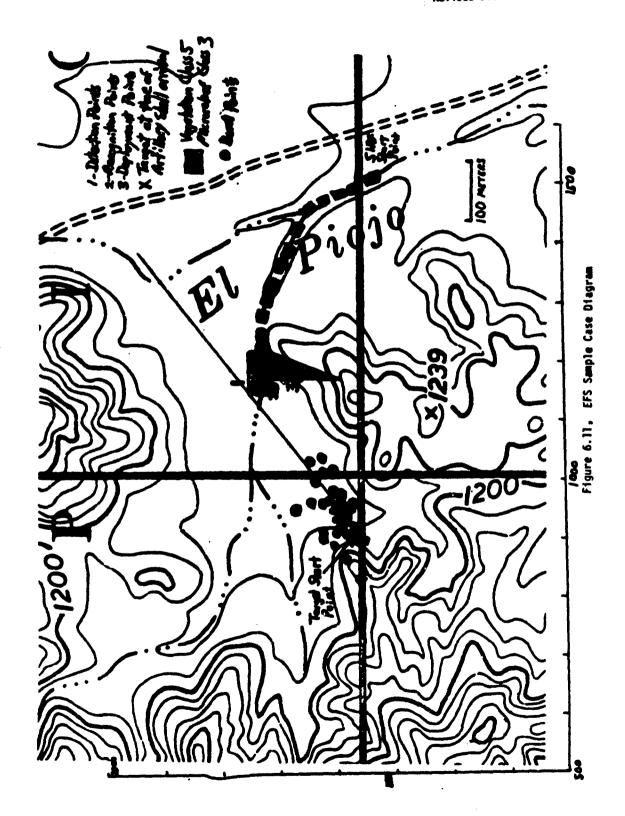
SCENATIC I				11)				
HUNTER LIGGETT SCENARIC		1.300	0.300	10 0.000 0.000 0.000 0.000	0000 50	MI NS) 0000 01 0000 00	1 30,000	. 510 .0.333
ヹ	EKTERNAL COMMUNICATIONS	ATTEMPTS HELV STANDAND DEVIATILM	COAPUNICATION SUCCESS HATTO	AVECAGE PCAEP LUSSES FOR COMMO FAILURES (PERCENT) ATTENDATION DUE TO VEGETATION 0.000	TOTAL TIME RECIEVING IDAYS, HAS, MINS	TUTAL TIME THANSMITTING (DAYS, MRS, MINS) WEAN STANDARD DEVIATION TUTAL TIME THANSMITTING (DAYS, MRS, MINS)	ANDERE MAS AUSTLANCE	AMPERE HAS UST. VERY VERY STACOARD PROFILM

SIAF HUMAN MAINTENANCE STATISTICS LAGE 101 HUNTFA LIGGETT SCENARIO I I AFPLICATIONS

	AVERAGE	700*	0.000	442.342 0.000			
	NIN	00000	200.0	0.000			
	XAM	•00•	0.000	846.215	PERFURMANCE DEGRADATION IFIRST REPLICATION ONLY!		
THE TOTAL TOMS	ENO.	***	3	846.215 0.000	N IFIRST REP	,	
	DEG INNI NG	0.0	?	0.0	E DE GRADATIO		
The second state of the second	HUMAN PERFORMANCE DEGRADATION	STANDARU DE VIATION	ENERGY - XPENDED (BTU)	STANDALD DEVLATION	TIME HISTONY OF HUMAN PERFURMANCI	PERF. DEG 300	

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STEET ALT THE SUPPORT BUKST PLINTS

K-Y COCFUINATES

K = 626.57 V = 1554.07
K = 647.43 V = 1554.41
K = 697.47 V = 1554.42
POSITION UF ATTACKER MU 1 X- 1164.33 V- 1674.72
POSITION UF ATTACKER MU 2 X- 1164.87 V- 1699.22
POSITION UF ATTACKER MU 2 X- 1164.87 V- 1699.22

Figure 6.12, EFS Sample Case Output

20000-0002-RO-00 Page 6-196 Navised December 1973

ATTACKER PATROL:			PATRUL	19 ME AME A		3 .				i
	7				•	•	•	•	•	-
FIRE TEAM MUNBER MEAPON TYPE	1-10(SA)	#-16(SA)	1 1 1 N - 1 6 1 SA)	1-16(4)	- 5 et -	1-14(54)	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1001014	•	į
CURRENT ANNO SUPPLY CASUALTY STATUS FIRMS STATUS	007	•		8 2 3		891	.]	00	0	
SION	0					9		90	٥	
CURRENT X (METER)	1166.87		1170-21	1168-16	11.72.06	1167.23	1170.76	1167.91	000	•
	1177.19	1175.20	1176.70	1177.67	1176.22	1176.16	1171.62	1174.74	0.00	
MENT V (METER)	1682.44	1668.86	1677.4	14.791	1672.48	1692.39	1658.00	1667.64	0.0	•
1	STAND	STAND	}] 5	3	0 1 N	51410	.50 .50 .50 .50	0.00	
MOVING STATUS	NORMAL	MORMAL	MOR		ı	NORMAL	MORMAL	MORMAL		
ROWDS REMAIN (MGG.)	70,	18.	202	~ 02		7 02	-2	7 02	00	
MOVEMENT RATE IN/S ECT	29 8ASF 63	29 29	A A CE FAN			NIFLERAN.	RIFLEMAN . 29	RIFLEMAN	00.0	9.6
	100		k	•	DASC FR.	100	100	100 100	0	
POSIT. IN FIRE TEAM SECONDARY MEAPON AVI	h. GREN.	* g :	AREA 2 H. GKEN.	AREA 3 F. GREN.	AREA 4 H. GREN.	AREA 5 H. GREN. 8	ARFA 2 4. Gren, 4	AREA 3 H. CRFW.	•	
NO.OF HAND GRENADE	7 ~	* 7	į	*0	1	•		*0	00	1
		;	1			:			* : :	i

ATTPISUTES AFTER EFS MUST

PATH CL MEMBER

DEFENCER PATROLS

	-		→				•	0	•	
HEAPON TYPE	14-47	K-+2	14-X							
URRENT AMMO SUPPLY	100	2	2	100	8	2	0	•	0	
ASUAL TY STATUS	MI . MOUND	MA . MOUND	3							
FIRING STATUS	2	TON	NOT							
UPPRESSION STATE							o	0	0	
CURRENT K (METER)	946.64	14.146	1	i	1	Į.	00.0	00.0	00.0	9
CURRENJ Y (METER)	1587.31	1500.53				_	00.00	0.00	900	••
×	00.0	0.00					00.0	00.0	0.00	0.0
HEXT Y (METER)	0.00	00.0	ı	ļ	•	1	00.00	0.00	0.00	9:0
ME IGHT (ME TER)	1.70	1.70					00.0	00.0	0.00	•••
Ī	.50	. 50	.50	.50	8	3.	00.0	00.0	0.00	0.0
CURRENT POSTURE	PACKE	MOM	ł	ł	ļ	•				
MOVING STATUS	MON	STUPPED							.*	
HAMEUVER UNIT		-					•	0		
ROUNDS REMAIN (MAG.)	20	20	62	92	2	2	•	0	0	
4	P.L.		RIFERM	RIFL EMAN	AIFL	AIFLEAM				
MOVENENT RATE (M/S EC)	.30		œ.	•30		*	0.0	8.0	00.0	0.0
HOLV. ASSIGNABAT	BASE FA.		BASE PR.	DASE M.	3	DASE PL				
INITIAL AMID SUPPLY	001		3	2		8	•	•	•	
EAPON TYPE	ARE A	AREA	AREA	AREA	111	3				
DSIT. IN FIRE YEAR			6	•		•	•	•	•	
ECCHOARY KEAPON AVI	NON E	MONE	MONE		40	*				
10.0F FAND CAENADE	0	0	•	•	0	•	0	0	•	
TOTAL STOKE CROSSES	0		 					-		

					:
100					POSITION OF DEFENDER WULL X- 945.47 V- 1587.17
	3				
618	KT I				! !
AIE	FR				•
36	H.TV				i
2	757				
	3				
3	H				ļ
	F TC		~	•	_
3	· S		4.5	9.0	7.1
127	IACT	918	167	169	158
3	COM	ř	<u>'</u>	,	خ
E	IKS		. 45	8.	14.
	BRE/	ğ	5911	116	946
-	æ	٢	¥	¥	×
CM	END	MAM	_ _	~ n	
200	96.5	E	X K	X	7
-	**	3	ACK	A CA	END
0	NO I	AKS	411	ATT	ÚĒF
BREAK DECISION : DEFENDER BREAKS CONTACT DUE TO LACK OF ADEQUATE FIREPOWER	BREAK DECISION : DEFENDER BREAKS CONTACT DUF TO HIGH CASUALTY FRACTION	100	POSITION OF ATTACKER MU 1 X- 1169.45 Y- 1674.52	٦	Ü
2	2		3	Z	S
MEA	HEA	FFER	TISC	1180	1150
		Ē	š	Z	

	522				
DEFENDED PATROL SUSTAINS THE NEXT CASUALTY THE NAMES OF THE CASUALTY MEMBER IS: 5 THE TYPE OF CASUALTY IS: MAJ. WOUND	POSITION : X- 1164.45 Y- 1674.52				

ATTRIBLIE TARLE AFT' CASUALTY SUSTAINED

ALIACASA PAPALLA	•	•	PATA	PATAUL MEMBER						
	• · · · · · · · · · · · · · · · · · · ·	7	~	•	S		,	8	•	-
FIRE TEAM MUMBER	-		•	-	-	•	•	•	•	
MEADON TYPE	M-16(SA 1	M-16(5A)	M-161 CA1	M-1 6(A)	10 02 -1	100	4-12.46	1 1 1 1 1 1	3	!
CURRENT AMMO SUPPLY	0.7						446 107 1	180101-4	•	
CASUAL TY STATUS	07	S	3			3	7 2	3	>	
FIRING STATUS	P011: 7			PO	PULL	100	TAILLY	TATO		i
=	0				•	•			•	
CURRENT X (METER)	1168.96	1 169.45	1170.28	1168-28	1172.11	1167.37	1170.78	1168.02		•
>	1044.03	1674.52	1095.57	1701.47	1691.05	1704.58	1669 83	1670.12		
×	1177.14	1173.28	1176.73	_	1176.22	1178-16	1171-82	1176.74		
-	1052.44	1662.86	1677.	_	1672.48	1092.39	1658-08	1667.64		
-	1.70	1.70	1.70	1.70	1.70	2.1	1.70	·i-	00.0	
MIDTH (METER)	05,	. 50	• 50	.50	20	3	20	4		
CURRENT POSTURE	STAND	STAND	\$11	ST	STAND	STAND	21.	STAND		5
MOVING STATUS	NORMAL	NOWAAL	NOR HAL	MORMAL	NURMAL	NORMAL	NORMAL	MOR MAI		
MANEUVER UNIT	7	-	~	~	~	7	-		•	
ROUNDS REMAIN (446.)	⊅	19	2	17	19	19	5		•	
FUNCTION IN PATROL	P.t.	A.P.L.	RIFERM	M. GUNNER	GR.LNCH.	RIFLERAM	RIFLEMAN	RIEI CMAN		
MOVENENT RATE (N/SEC)	•5•	.29	• 29		. 29	2	. 29	20	00.0	7 0
INDIV. ASSIGNMENT	BASE FR.	H. UNIT	BASE FR.	BASE	DASE F	BASE FR.	F. UNIT	M. UNIT		5
INITIAL AMMO SUPPLY	100	1 00	001	100	9	81	100	100	0	
WEAPON TYPE	AKE A	ARFA	AREA	AREA	AR EA	AREA	AREA	ABFA	•	
POSIT. IN FIRE TEAM			~	M		•	7		c	
SECONDARY MEAPON AVE	H. GREN.	H. CREN.	H. GREN.	F. GREN.	H. GREN.	H. GREN.	H. GREN.	H. GREN.		
_	*	•	*	•	*	•		•	•	
MC.OF SMOKE GRENADE	7	2	9	0	0	0	3			

DEFENCER PATROL:			144	ATKCL NEMBE						
		~	M)	•	•	•	-	3		:
FIRE TEAN NIMBER			-		•					
WEAPON TYPE	64-47	1X-47	7K-47	74-44			0	3	0	
CURRENT ANN SUPPLY	100		i -	,			•	,		
CASUAL TV STATUS	PI-FCUND	H. A.	9	DEAD	3	3	5	6	0	
FIRING STATUS	71.7		Z		TON.	NOT THE				
THE NUMBER OF STREET	? (}	3	. 	0	•	0	c	G	•	
CANTER A LEGISTA	L + * 0 + 6	41.41	\$6.03	938.24	952.71	941.41	00.0	0000		
	1587-17	1589.53	1583.27	1593.43	1579.37	1589.53	0	0000		
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	ָם מינים מינים	o , 0	8.0	?°0°0	8	3.	00.0	0.0		
		š.	3	00.0	9.0	00.0	00.0	3.30	0-03	
HOLD ACCION	2.4	5.1	_	1.73	1.70	1.70	00.0	000	0.00	
CHESCHY BOCK, 100	2	000	95	20	. 50	. 50	00.00	3.03		
MONTH CTATES	TONG.		×	PROME	PROME	PRONE			22.5	
MANEUVER UNIT	• • • • • • • • • • • • • • • • • • • •	2 10775	rge se.	STOPPED	STUPP EU	STOPPED				
ROUNDS REPAIN (MAS.)	ب ما	- 00	7	~		-	0	9	C	
FUACTION IN FATROL	a	APPLE	R I FI F MAN	07	02	22	0	0	•	:
MOVEMENT RAT= [M/SEC)	- 1	. 30		.30	OK T	MIT LEMAN	5		;	
MADIA ANDIONALL	PASE	BASE FR.	BASE FR.	BASE FR.	BASE FR.	RASE FR.		50.0	00.0).
MEADON TYPE	100	1 00	100	100	3	31	•	n	-	
POSIT IN CIPE TAN		ANEA	AREA	APEA	AR EA	AREA	•	•	,	
SECONDARY MEADON 1117	-0 1.	7	~ 0 ;	4	5	•	2		-	1
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NO OF THORE OF PARTIE	ه إد ا ا	>k	0	ا	0	o ,	•	O	o	
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DEFANS CONTACT CLF TO LACK OF ADECIDATE FIREHOMEN FINANS CONTACT CON TO HIGH CASHLITY PARCTICA JEFFER JEF And State of BREAK DECISION: RRESK OFCISION :

				• • • • • • • • • • • • • • • • • • • •	
SUPPORT BURST PUINTS	11. 77 16. 44 15. 30				
F 18 2 21 7 . 15 109 9 . 00	1 X- 1170.35 V- 1696.44 2 X- 1170.26 V- 1696.44 1 X- 944.12 V- 1585.30				
X = 965.92 Y = 101 X = 1014.74 Y = 164 X = 1034.45 Y = 164 X = 1034.45 Y = 164	OF ATTACKER NU OF ATTACKER NU OF DEFENDER SU		de de la completa de la completa de la completa de la completa de la completa de la completa de la completa de		!
X = 100 X = 10	POSITION OF POSITION OF				

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30000 6 0 000000 00 0.00 0 00 225 1169-46 1676-82 1174-74 1467-64 1-70 57 AND STAND NORMAL H-16 (SA RIFLEMAN GR EN M-16 (SA) 99 NO NO NO 1171.03 1666.95 1171.62 1658.00 ST AND MORMAL RIFLEHAN GR EN. H-1615AJ 11702.42 11702.42 11702.39 1692.39 STAND NORMAL CA.LNCH. RIFLEMAN BASE FR. GREN. -BASE FR. ' ಕ| GREN. STAND 1 į M-16(A) 97 MO MO PATROL NENGER M.GUNNER GREN 1169.88 BASE 8 2 <u>5</u> 1111-24 1692-85 11176-70 1677-46 1-70 50 STANO NOR MAL PIFENAN . 29 M-161 SAD AREA 100 GR EN. BASE ij NO NOT ~ 1871.77 17.20 STAND 1001 1662.16 GREN. 1696.44 STAND F. 100 100 ARE A F-16(SA) GREN BASE Į, WEAPON TYPE
CURRENT ANNO SUPPLY
CASUALTY STATUS
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FUNCTION IN PATROL SECONDARY WEAPON AVI INITIAL AMMO SUPPLY WEAPON TYPE POSIT. IN FIRE TEAM SMOKF GRENADE INDIN. ASSIGNMENT ATTACKER PATROL NO.OK

BEST

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ATTAIBUTES AFTER

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DEFENCER PATROL:			PATRU	ICL MEMBE	۔					
	- -	'2	T	•	5	•	-	10	•	
FIRE TEAM NUMBER	:	-	-	-	1		o	0	0	, 1
MEAPON TYPE	AK-47	74-XV	AK-47	AK-47	AK-47	AK-47	,	•	•	
CURRENT AMMU SUPPLY	100		801	130	•	8	0	0	0	
CASUAL TY STATUS	FI . MOUN!	MA.HUUNU	3	DEAD	MA. HOUND	AA. MOUND] . !	•	1	: •
FIRING STATUS	T ON	TON	NOT	TON		10₹				
SUPPRESSION STATE		-	~				0	0	0	
CUPRENT X (NETER)	344.12	14.146	947.25	934.28	952.71	941.41	0.00	00.0	00.0	0
>	1585.30	1589.53	1581.40	1593.43	1579.37	1589.53	0.00	0000	00.0	0
NEXT X (METER)	0.00		•	00.0			00.0	00.0	000	0
	0.00	2.00	3.0	00.0	i	8.0	00.0	2.00	0.00	0
METCHT (METCH)	1.73		-	1.70		-	00.0	000	0.00	0
WIDTH (METER)	.50			.50		•	00.0	0.00	000	•
NTFO	PRONE	PRONE	PR	PRONG	PRONE	P				4
MOVING STATUS	TUP SP.	STOPPED	TOP SP.	STOPPED	STOPPED	STOPPED				
MANEUVER UNIT		-	-	-		-	0	0	0	
ROUNDS REMAIN (MAG.)	0.2	20	20	20		22	0	0	0	
FUNCTION IN PATRUL	P.t.	A.P.L.	R I FLE MAN	RIFLEMAN	RIFLEMAN	RIFLE				
MOVEMENT RATE (M/SEC)	•30		.30		• 30	. 30	0.00	00.0	0.00	0
IMDIV. ASSIGNMENT	BASE FR.	BA SE FR.	BASE FR.	BASE FR.	BASE FR.	BASE				
INITIAL AMMO SUPPLY	001		81	100	00		0	0	0	
MEAPON TYPE	ARE A	AREA	AREA	AREA	AR FA	AREA			•	
POSIT. IN FIRE TEAM	-	2	3	•	5		0	0	0	!
SECONDARY WEAPON AVI	N S	N.JNE	NCNE	NONE	NON	MON				
	0	0	၀	•	0	0	0	0	•	
MULCE STOKE GRENADE		0	0	0	0	0	 	0	0	l

BREAK OCCISION : DEFENDER BREAKS CONTACT DUE TO LACK OF ADEQUATE FIREPONER

DEFENDER PREAKS CONTACT DUE TO HIGH CASUALTY FRACTION BREAK DECISION :

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ST POINTS	03 43		
X-Y COCRDINATES OF EXTERNAL FINE SUPPORT BURST POINTS X = 860.46 V = 1575.04 X = 933.84 V = 1610.04 X = 949.04 V = 1571.41	40 1171.25 V- 1669.03 1171.53 V- 1693.85 941.76 V- 1583.43		
S OF EXTERNAL F V = 1575. V = 1610. V = 1571.	TACKER NU 1 X- TACKER NU 2 X- FENDER NU 1 X-		
X-Y COCRDINATE X = 940.46 X = 933.84 X = 949.04	M 993.72 POSITION OF AT POSITION OF OF		

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ATTRIBLIES AFTER FS BUPST

ATTACKER PATRCL:	ı		PATROL	I MENDER			-			1
	- :	~	3	•	•		•	•	~	-
FIRE TEAM NUMBER WEAPON TYPE	\$1914	1 M-16(SA)	1 N-16(SA)	H-16(A)	1 ₩-79 GL	1 M-16(SA)	1 1-16(SA)	#-16.5A)	0	
CURRENT AMMO SUPPLY	5 C	& Z	\$ §	26 7	S 3	8 9	S i	66	9	
FIRING STATUS	I ON	NON	10	9	? 5 2	202	100	M 100		
215	0	0	9	0	0	0	0	0	0	
×	11 71.53	1171.25		1171.49	1173.3	1171.20	1171.29	1170.90	0000	•
ENT Y	1693.45	1669.03	1690.13	1696.67		1700.26	1664.07	1674.31	0.00	•• ••
	1177.19	1173.20		1177.67		1174.16	1171.02	1174.74	0.00	6
MEXT Y (AETER)	1082.44	1662.86	1677.46	1687.41		1692.39	1658.08	1667.64	0.0	
HEIGHT (METER)	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	00.0	••
MIDIN (MFTER)	0 \$ 0	. 50	.50	.50	. 50	.50	.50	.50	000	ö
CURRENT POSTURE	STAND	STANO		STAND	STAN	STAND	STAND	STAND	1	1
MOVING STATUS	TOWNE	NOW HAL	NOR FAL	NURMAL	Z	NORMAL	NORMAL	MURMAL		
MANEUVER UNIT	7		~	7	7	2	~	_	•	
ROUNDS REMAIN (MAG.)	61	61	61	11	61	61	61	6	•	
FUNCTION IN PATROL	P.L.	A.P.L.	R IFLE MAN	M.GUNNER	GR.LNCH.	RIFLEMAN	RIFLEMAN	AIFL ENAN	•	
MOVERENT RATE (M/SEC)	70.	• 50	67.	67.	62.	62.	67.	.29	0.00	0
INDIA. ASSIGNMENT	BASE F4.	M. CNIT	BASE FR.	DASE FR.	BASE FR.	BASE FR.	F. CNIT	M. CNIT		
INITIAL AMMO SUPPLY	001	1 00		100	•	8	100	100	0	
WEAPON TYPE	ARE A	AREA	AREA	AREA	AREA	AREA	AREA	AREA		
POSIT. IN FIRE TEAM	7	-	~	M		•	~	~	0	
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	.c	AK-47	MA. MUUND	152.71	322	PRUNE STOPPED	IFLEMAN A	ASE FR. BA	VUV.	2
HCL NEMBE	•	AK-47	JEAU NJT	1593.43	2.20	PRONE STOPPED	PIFL SMAN A	JASE FR. B 103 AREA	NOV	10
		\$		1574.91	30.0	TOP SP.	RIFLEMAN	ASE FR. 100 AREA	T UNCO	0
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		AK-4-7	107	1583.43	5.7.0	TOP SP.	3 -0	ANSE FR. B	* # O	,
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	-	# 3 4 # U.U	2 3 3	CURR NEXT	H H H	ROY	7 N N	POST	NO. C	

BREAK DECISION I DEFENJEN MAKAKS CONTACT LUE TOTAĞK UF ADFENATE FINEPONEF FULLES GURTACE DE- TO MIGH CASIBLEY FEBUTION 321 18 3436 BEEAK DECISION:

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ATTRIBLTES AFTER FFS HUNST

Best Available Copy

PATHCL NEMBER

DEFENCER PATHCL:

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NCNE MONE

BREAK DECISION : ATT ACKEN BREAKS CONTACT OUE TO EXCESSIVE ELAPSED TIME (FIGHT)

BREAKS CONTACT DUE TO LACK OF ADEQUATE FIREPOWER DE F FNDEK BREAK DECISION :

BREAK DECISION: DEFENDED BEGAKS CONTACT DUF TO MIGH CASUALTY FMACTION IC FOR BREAK CONTACT-AVAILABLE SIAF RALLY PHINT 1470.9600 T644.5567 TACKEP WITHOUGHALL CUTES

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MST POINTS 5.65 6.72 9.72	ATTACKER WITHDRAWAL WANTES 1172. 81 1470.96 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.90 1172. 81 1470.80 11				
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> 00000 0 000000 0 00 0.00 0 00 255 STAND 1653.63 .50 1.38 RIFLEMAN 671-15 LIND M-16 (SA) 1471.51 GREN 100 STAND 100 1182.36 1640.56 1470.41 1643.69 REPLEMAN CAEN. ž BASE FR. 100 AREA 16.77.08 16.50.08 1.70 0.70 0.70 0.70 GRILLENAN AIFLEMAN IVS 191-H GREN. TOP SP. į 1449. **86** 1638. 72 1. 70 8 STAND AR EA 3: BASE FR. ತ SEN. 10P SP. 57 į - 3 <u>-</u> PATROL MEMBER 1103.03 1692.01 1471.51 FR. 100 .50 STAND 80.1 M.GUNNER 1653.63 GREN. 1511 S BASE **2 3 5** 1163.69 ST AND R IN E MAN BASE FA. 100 AREA 1643.69 40 H-16(SA) GR EN. ş Ï 232 . 50 STAND ~ 1 555.65 H-1665A1 1102.97 3.31 001 SP. EE. NON BASE FR. STAND ARE A 1689.73 1470.96 1648.66 SEC #-161SA 1183.5 BCM ST ATTRIBLTES AFTEL EFS ROUNDS REMAIN IMEG.) FUNCTION IN PATROL MOVEMENT RATEIN/SEC) SECONDARY MEAPON AVI NO.OF HANG GRENADE CURRENT AMO SUPPLY INITIAL AMMO SUPPLY POSIT. IN FIRE TEAM SMOKE SKENAUE (METER) (METER) NCIV. ASSIGNMENT CASUAL TY STATUS FIRING: STATUS SUPPRESSION STATE CURRENT X (METER) METER ATTACKER PATROL RUARER CURRENT POSTURE MOVING STATUS MANEUVER UNIT MEAPON TYPE HEAPON TYPE CURRENT Y **HE 1917** HIOIM 80.0H

FIRE VEAM MUNMEN AK-47 CURRENT AMMO SUPPLY 120 CASUALTY STATUS CASUALTY STATUS CASUALTY STATUS CURRENT STATUS CURRENT K (METER) MEXT X MEX X METER MEXT X (METER) MEX X (METER) MEX	AK-47 AK 1.00 1.00 1.00 1.00 1.70 1.	1. AK. AK. 1. AK		AK-41 1000 MA. WOUND NOT 1509.53 1.70 1.70 1.70 8161.60 8100000 8161.6				0 0 0 0 0
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ATTACKER MU 1 X- 12 ATTACKER MU 2 X- 12 DEFENDER MU 1 X- 9	0	0		0	n	ဂ	•	
ATTACKER MU 1 X- 12 ATTACKER MU 2 X- 12 DEFENDER MU 1 X- 9								
ATTACKER MU 2 X- 12 DEFENDER MU 1 X-	35 4- 1444	4						
DEFENDER MU 1 X-	- A 44	13				-	-	!
	1 -A 1+	93						
TANDEVENT	TS TN 20 SECT	SNOS				:		1
OF ATTACKER MU	.93 Y- 1663	. 29						
POSITION OF ATTACAGE NO 2 X- 1220.	. 00 V- 1est	 	·			•		;
OF DEFENDER 40	-13 T- 1316	01.						

	And the second of the second o										• •
IN SO SECONDS	1.		IN 20 SECUNOS. 4 V- 1660.73 0 V- 1678.39	2 2	284.34 Y- 1675.33 913.67 Y- 1560.94	309.50 Y- 1658.18 305.79 Y- 1672.26 908.99 Y- 1557.19	ENTS IN 20 SECUNDS. 331-13 Y- 1656.91 327-24 Y- 1669.20 904-30 Y- 1553.44	ENTS IN 20 SECONDS. 352.76 Y- 1655.63 348.69 Y- 1666.13 899.62 Y- 1549.69	NO EVENTS IN 20 SECONDS. 1 X- 1374.39 V- 1654.35 2 X- 1370.14 V- 1663.06 1 X- 694.93 V- 1545.94	ENTS IN 20 SECUNDS. 390.01 Y- 1653.08 391.59 Y- 1660.00 890.24 Y- 1542.20	AN E VENTS IN 20 SECUNDS. X- 1417.64 Y- 1051.8C
	MU 1 X- 1	#U 1 ×	1 NO EVENTS IN KER MU 1 X- 1266.24 KER MU 2 X- 1262.90	21 NO E VENT S IN 21 NO E VENT S IN KER MU 1 X- 1287.87	#U 2 X- 1	MU 1 X- 1 NU 2 X- 1 MU 1 X-	NU E V NU 1 X- 1 NU 2 X- 1	NO EV NU 1 X- 1 NU 2 X- 1	333	N	 ?
	POSITION OF ATTACKED POSITION OF ATTACKED	Ö	= 6 5	POSITION OF DEFENDER 1 6 21 21 POSITION OF ATTACKER	66	POSITION OF ATTACKER POSITION OF DEFENDER	POSITION OF ATTACKER POSITION OF DEFENDER	POSITION OF ATTACKER POSITION OF ATTACKER POSITION OF ATTACKER POSITION OF DEFENDER	POSITION OF ATTACKEN POSITION OF ATTACKEN POSITION OF DEFENUER	POSITION OF ATTACKED POSITION OF ATTACKED POSITION OF DEFENORE	POSITION OF ATTACKET

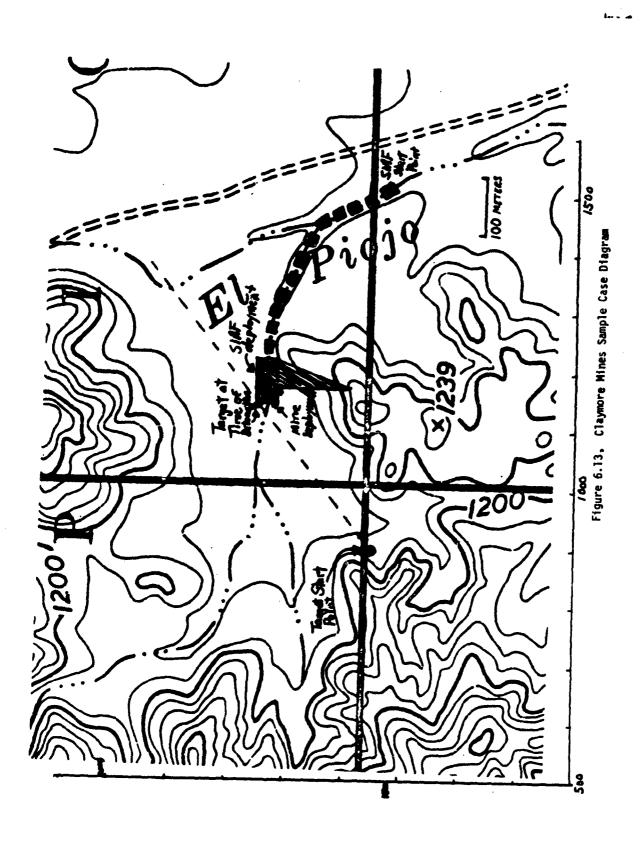
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FIRE TEAM NUMBER WEAPUN TYPE CURRENT AMMU SUPPLY CASUALTY STATUS FIGHER		~	•	*			~	*	6	(
PULY										
A I dd			-	-	-	-	-	•	c	
PULY	4-10 (SA)	V-16(5A)	H-1615A1	4-101A	M-73 GL	M-15 (SA)	1421A1-K	Me 15 CA1		1
CASUALTY STATUS	66	66	66	~		3	0	7	•	
FIDING CTATIS	2	2	Ž	CZ	2	2	. S	2	•	
	. LON	101	N OT	2	JUN	E	NOT.	111		
SUPPRESSION STATE	၁	0	0	•	C			} ~	<	
	1465.41	1 470.96	1466-10	1405.46	1465.85	1465-63	1470-35	1467.87	00-0	3.6
CURRENT Y (MFTER)	1549.38	1640.66	1644.32	1654.31	1539.16	1059.31	1643.69	1654-85	0.00	
(METER)	1470.96	1 4 70 . 96	1470.41	1471.51	1463.86	1472.06	1470-41	1471.51		
NEXT Y (METER)	1048.66	1648.00	1643.69	1653.03	1638.72	1658-60	1643.69	1653.63		d
(NETER)	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	0.00	
(NETER)	• 50	. 50	.50	.50	200	9	250	65	0.0	
u) a	STAYE	_	STAND	STAND	STAND	STAND	STAND	STAND) }	•
	TOP SP.	TCP SP.	TOP SP.	T. Sp.	TOP SP.	10P SP.	TOP SP.	TOP SP.		Ì
MANEUVER UNIT	′۷	-	~	~	~	7			G	
ROUNDS PERAIN (MAG.)	61	61	61	17	19	61	19	• =	• •	
FUNCTION IN PAIROL	p.l.	A.P.L.	RIFLEMAN	M. GUNNER	GR. LNCH.	RIFLEMAN	RIFIEMAN	RIFLEMAN		į
MOVEMENT RATE (M/SEC)	1.38	1.08	1.08	1.08	1.08	1.08	1.08	1.08	00.00	0.0
	BASE FR.	M. UNIT	BASE FR.	RASE FR.	BASE FR.	BASE FR.	TIND "	T CALT		•
INITIAL ARNO SUPPLY	130	100	100	100	0	1 30	100	100		!
MEAPON TYPE	AKE A	ARFA	AREA	AREA	AR FA	AREA	AREA	ARFA	,	
POSIT. IN FIRE TEAM	~		7	m	4		~		c	
SECONDARY WEAPON AVI H.	H. CREV. F	4. GKEN.	H. GREN.	F. GREN.	H. GREN.	H. GREN	H. GREN.	H. GREN.	:	ı
	4	*	*		4	4		*	O	
NO.OF SHOKE GRENADE	~		0	ဂ	0	O	0	0	· ·	

			~	m	.	.	9		60	•	
V	UMBER	i	1					0	0	0	1
	EAPON TVPE	AK-47	AK-47		74-44 100	AK-47	¥	•	c	c	
1524-21 1589-53 1525-30 1593-43 1579-37 1589-53 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.		CI LINE	NA LES	CALL LA) (FA)	CMILCIA - AM	OH THE	3			1
15.29-21 15.89-53 15.25-30 15.93-63 15.79-31 15.89-53 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	INTAG STATUS	100	401	TON	TOW.	NOT					
15.9.2.1 941.41 97.13 938.26 932.71 941.41 0.00 0.00 0.00 15.9.2.1 15.99.53 1525.30 1593.43 1579.37 15.94.53 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	JPPRESSION STATE	0	0	0	0	C	C	0		0	- 1
1524.2 1589.53 1525.30 1593.43 1574.37 1509.53 0.00 0.00 1524.2 1589.53 1525.30 1593.43 1574.37 1509.53 0.00 0.00 1.70	BRENT X (METER)			7	?	952. 71	14.146	00.0	!	0.00	
Here Here	PRENT V (METER)		1589.53		1593.43	1579.37	•	0.0		0.00	
	•		00.00	•	00.0		9.	0.00			
1.70		00.0	00.0		00.0	Ö	3	00.0			
PRONE PRON	· =	1.70	1.70	_	1.70	-	-1	00.0			
TOP SP			. 50	•	.50	•	•	00.0			- 1
TOP SP. STOPPED TOP SP. STOPPED STOPPED STOPPED 1	0	PACK.	PRONE	PRO	PRONE		240				1
Color	NING STATUS	TOP SP	STOPPED	404	STOPPED	2	STOPP				
	NEUVER UNIT	;	-	,	-			0	0	9	
	SUNDS REPAIN (MAG.)	20	20	20	20	20		0	0	0	Ŀ
SEC1 33 0	INCT TON IN PATROL	b to	4	R IFLEMAN	PIFLEMAN	RIFLEMAN	FIFLER				
LY 100 100 100 100 100 0 0 0 0 0 0 0 0 0	DVENENT RATE (M/SEC)	30	•	8	.30	30	•		0		
AN 100 100 100 100 100 100 0 0 0 0 0 0 0	IDIV. ASSIGNMENT	PASE FK.	4 SE F	ASE	"	-	BASE F				
FEAM 1 2 2 3 4 5 6 0 0 0 0 0 0 0 0 0	ITTAL ANNO SUPPLY	100))	130	~		0	0	0	
FE TEAM	APON TYPE	AREA	AREA	AREA	ARSA	AR EA	*	i			
A A NONE NONE NONE NONE NONE NONE NONE NO	ISIT. IN FIRE TEAM	-	2	-	•	5	•	0	0	0	
X	CONDARY WEAPON AVI	A NON E	NONE	NON	NON	ACA A				•	
X - 1430,95 V - 1625,60 TARGET DETECTED: VES TIME: DAYS-01 HOURS-08 MINUTES-VIA = 1576 LOS = 1	DOOF HAND GRENADE	0	0	0	C	•		0	0	0	,
x - 1430, 95 Y - 1625,60 TAR GET DETECTED: VES TIME: DAYS-01 HOURS-08 HINUTES- YTAR = 1576 LOS = 1 Image: CETECTED: VES VES VES VES-01 HOURS-08 HINUTES- YTAR = 1575 LOS = 1 Image: CETECTED: VES VES VES-01 HOURS-08 HINUTES- PGET 10. 1 VIS UALL V VES VES VES-01 HOURS-08 HINUTES- A - 1371,60 V - 1591,40 TAR GET DETECTED: VES VES YTAR = 1576 LUS = 1 HGET VO. 1 VIS UALL V	i	0	0	0	0	0	0	0	0	0	!
VIAR = 1576	;	!				,		10-3240			1
	×į	- (וח	192 661	חבוברובהי				200)	
X-1422.40 Y-1620.67 TAKGET DETECTED: YES TIME: DAYS-01 HOURS-03 MINUTES- VTA = 1575 [15	AIT SET TENTE TAUGHT	0) (1 -	3 _								
VTA # 1575 [13 = 1] PGET 10. 1 VISUALLY A = 1371.60 Y- 1591.40 TAKGET DETECTED: VES TIME: DAYS-01 HOUKS-0H MINUTES- VTA # = 1576 [US = 1] HGET 40. 1 VISUALLY	AF PCSITION: X- 14	•	'n		CETECTED 	¥	TIMES	5	HOUR S-03		
PGET 10. 1 VISUALLY A-1371.60 Y-1591.40 TAKGET DETECTED: YES TIME: DAYS-01 HOURS-0H MINUTES- YTAP = 1576	•	1	. 563			: :					1
	IAF DETECTS TAPGET	5.	> -					04VC=01	ACC. SACA		
AGET 40. 1 VISUALLY		→ (0111110	•	1	10-5110	en andres	1	i
	و	NISIA I	1 . 1 .	•							



ATTACKER PATROL:		~	PATRI	PATROL MEMBER	\$	•	7	•	•	
	•		•	-	-	-	•	-	•	
MEADUR TYPE	1 17 17 17	H-16/541	142/41-4	H-16(A)	10 et -10	H-16(SA)	M-16(SA)	H-16(SA)		
ANNO SJPPLY	100	100	•	100	•	8	100	100	•	
STATUS	2	₽				2	ON			
FIRING STATUS	TON				101	100	103		,	
SUPPRESSION STATE	0	•	•	•				0	• ;	•
(METER)	1157.41	1160.53	1163.66	1166.70	٦	7	1176-15	1179.27	8:-	3
(METER)	1716:73	1719.22	17.		-		1731.72	173	8	0
(METER)	00.0	00.0	00.0				0.00	0.00	8	0
(METER)	0.00	00.0					00.0		8.	•
(METER)	1.70	1.70			2:1	1	1.70		3-	Ĭ
(NETER)	.50	.50	.50						3	<u>.</u>
POSTURE	CROUCH	CROUCH		CAOUCH		5	C	9		
MOVING STATUS	STOPPED	STOPPED	STOPPED			5	STOPPED	STOPPED		
MAMEUVER UNIT	~	-	~	~	~	~	-	-	•	
COUNTY REMAIN (MAG.)	20	20	20			20	20	20	•	
IN PATROL	P.L.	A.P.L.	AIFLEHAN	M. GUMBER	2.5	RIPLEMAN	WIFLEHAN	RIFLEMAN		
MOVEMENT RATE (M/SEC)	00.0	0.0			•	8	0.00	0.00		•
SIGNAENT	BASE FR.	H. CALT	BASE FR.	BASE	BASE FR.	DASE FR.	M. CALT	2		
INITIAL AMMO SUPPLY	100	8				100	100	001		
SAYT NC	AREA	AREA		MEA	AREA	AREA	AREA			
FIRE TEAM		-			•	•	2	•	0	
SECONDARY WEAPON AVI	H. CAEN.	H. CATEN.	H. CAEN.	H. CAEN.	H. GREN.	H. GATEN.	H. GALGA.	M. BAEM.	1	
NO.OF HAMD GRENADE	•		*	◀	•	•	•	•	0	
MO DE CAMPE CREMANE	~	~	•	•	0	0	0	0	0	

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Figure 6-14. Combat Outputs for Claymere Mines Sample Case

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0		0000		0	0.00	9 0 0
AR-47	0 TO 0	1753.90	1.70	STAND NORMAL 1	IFLEMAN 30 ASE FR.	AREA BNOWE
AK-47	3 T 0	1742.19	2.0	STAND MORMAL 1	RIFLEMAN N 30 100	AREA S NONE O
1 AK-47	NO NO T	0.00	50	MORMAL	RIFLEMAN 130 SASE FR. 100	AREA NONE
100	NO TON	1746.10	1.70	NORMAL 1 20	RIFLEMAN .30 BASE FR. 100	NON E
AK-47 100	NOT NOT 0	0.00 0.00 0.00	1.70 50 50 50 50 50		A.P.L. 30 84 SE FR. 100	AREA NONE 0
4K-47	NOT 0 0 1150.00	1750.00 0.00 0.00	1.70 5.3 STAND	NORMAL 1 20	90 90 130	AREA NONE 0
FIRE TEAM NUMBER JEAPON TYPE SURRENT ANNO SUPPLY CASUALTY STATUS	SSF	CORRES Y CRETERS REXT X CRETERS REXT Y CAETERS	MIDTH (METER)	MONING STATUS MANGUYER UNIT ROUNDS RENAIN (MAG.)	MOVEMENT RATE(N/SEC) MOIV. ASSIGNMENT INITIAL AMO SUPPLY	POSIT. IN FIRE FEAM SECONDARY WEAPON AVI NO.OF HAND GRENADE NO.OF SMOKE GRENADE

DEFENDER PATROL:

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1720.63 XMINE 1154.29 VMINE X XMINE X XMINE X XMINE X XMINE X XMINE X XMINE X XMINE X XMINE X XMINE X XMINE X XMINE X XMINE X

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ATTRIBUTES AFTER DETONATION OF MINES

ATTACKER PATROL:	-	2	PATR	PATROL MEMBER	•	•	4	•	•	-
			,		,		,			
FIRE TEAM NUMBER	1	-	7	7	1	-			•	į
AEAPON TYPE	175191-H	1914	191-4	91-1	H-79 EE	H-1615AT	125191-M	M-1615A1		
CURRENT AMMO SUPPLY	100	001	100	100	•	3	100	100	•	
CASUALTY STATUS	2	2			2	₹	9	9		
FIRING STATUS		Ē	5	101	Ē	5	8	5		
SUPPRESSION STATE	•	0	•	•	•	•	•	•	0	
CURRENT' K (METER)	1157.41	1160.53	1163.46	1166.78	1169.90	1173.03	1176.15	1179.27	8.0	· · · ·
CURRENT Y (METER)	1716.73	E		-	1	1729.22	1731.72	Γ-	00.0	0.0
VEXT X (METER)	00.0						0.00		8.0	••
NEXT Y (NETER)	00.0	•	00.00	00.0	8.0		0.00	0.00	8.0	0.0
HEIGHT (METER)	04.1						1:10	1	9.00	9:7
MIDTH (METER)	.50					3	.50		8.0	 0
CURRENT POSTURE	STAND	5	STAND		STAND	STAN	STAND	STAND		
MOVING STATUS	STOPPER	STOPPED	STOPPED	STOPPED	SYDPPED	STOPPED	STOPED	STUPPED		
MANEUVER UNIT	~	-	~	~	~	~	-	-	•	
ROUNDS REMAIN (MAG.)	02	20	20	2	20	02	20	20	•	
FUNCTION IN PATROL	P.t.	1.7.1.	RIFLEMAN	H. CUMBER	BR.CHCH.	RIPLEMAN	RTPLEMAN	RIFLEHAN		
HOVENENT RATEIN/SEC)	00.0	0.0	0.0	3	8.8	9. 0	0.0	00.0	8.0	••
INDIV. ASSIGNMENT	BASE F4.	<u>.</u>	BASE FR.	DASE FR.	DASE FR.	BASE FR.	F. 517	A. SIT		
INITIAL AMMO SUPPLY	130		100	100	•	100	100	100	0	
JEAPON TYPE	AREA	AREA	AREA	AREA	AREA	AREA	AREA	AREA		
POSIT. IN FIRE TEAM	1	-	~	•	•	•	~	~	0	
SECONDARY WEADON AVI	H. GREV.	H. GREN.	H. GREN.	H. GREN.	H. GREN.	W. GREN.	H. GREN.	H. GREN.		
HO.OF HAND GRENADE	•	*	•	•	•	•	•	•	•	
40.0F SMOKE GRENADE	2	2	0	0	0	0	0	0	0	

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NUMBER AK-47	NUMBER AK-47 AK-			7		•		•	1	•	•	
AND SUPPLY DEAT AK-47 AK	PER SUPPLY 100 100 0EAD DEAD 100 100 100 100 100 100 100 100 100 10	FIRE TEAM MINBER		1					0	0	0	
NWO SUPPLY 100 100 100 100 100 100 100 0 00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	STATUS STATUS DEAT DEAD DE	SAAT NCAVE	AK-47	AK-47	•	AK-47	AK-47	AK-47				
STATUS DEAT DEAD DEAD DEAD DEAD DEAD DEAD DEAD	STATUS DEAN DEAN DEAN DEAD DEAD DEAD DEAD DEAD	CJARENT ANNO SUPPLY	100	001			3		•	•	0	
ATUS. NOT NOT NOT NOT NOT NOT NOT NOT NOT NOT	ATUS NOT NOT NOT NOT NOT NOT NOT NO	CASUALTY STATUS	DEAN	DEAD	;	0	DEAD	ļ :				!
ON STATE 1150.00 1154.86 1153.12 1143.75 1156.28 1146.86 0.00 0.00 0.00 0.00 0.00 0.00 0.00	ON STATE 1150.00 1165.00 1153.12 1153.75 1156.25 1156.86 0.00 0.00 0.00	FIRING STATUS	LON	MOV			MOT					
Heter 1150.00 1156.06 1153.12 1153.25 1156.26 0.00 0.00 0.00	Here 1150.00 1156.06 1153.12 1153.75 1156.25 1156.26 0.00 0.00 0.00	SUPPRESSION STATE	•	0	0	0	•	0	0	0	0	
HETER 1753.00 1753.90 1746.10 1757.01 1757.01 1753.90 0.00 0.00 0.00 0.00 0.00 0.00 0.00		CLERENT X (METER)		1146.86	1153.12	1143.75	11 56.25	1146.30	0.00	0.00	8.0	Ö
HETER 0.00	HETER 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	CURRENT Y (METER)		1753.90	1746-10	1757.81	1742.19	1753.90	0.00	0.00	8.0	Ġ
HETER 0.00	HETER 0.00	•		00.00	0.00	00.0	0.00	•	00.0	0.00	8.6	ö
NETTER 1.70 1.70 1.70 1.70 1.70 1.70 1.70 0.00 0.00 0.00	NETRE 1.70 1.70 1.70 1.70 1.70 0.00 0.00 0.00 NETRE 1.70 1.70 1.70 1.70 1.70 1.70 0.00 0.00 0.00 NETRE 1.50 1.70 1.70 1.70 1.70 0.00 0.00 0.00 NORAL STAND STAND STAND STAND STAND 0.00 0.00 0.00 NORAL	· >		0.00	0.00	00.0	0.0		00.0	0.00	8.0	ö
NETTER 1.50	NETER STAND ST	+	-	1.70	۲.	1.70	1.70		00.0	00.00	0.00	ö
OSTURE STAND	OSTURE STAND			.50	.50	, ,	.50		00.0	0.00	0.00	ö
ATUS NORMAL NORMAN RIFLEMAN R	ATUS NORMAL NORA	0	STAND	1	STAND	S	STAND	ļ		!		i
UNIT (MAG.) 20 20 20 20 20 0 0 0 0 0 0 0 0 0 0 0 0	UMIT 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0	v	NOR MAL	NORMAL	NORMAL	Q	MORMAL					
NAIN (MAG.) 20 20 20 20 20 20 20 20 20 0 0 0 0 0 0	NAIN (MAG.) 20 20 20 20 20 20 0 0 0 0 0 0 0 0 0 0	MANEUVER UNIT	•••			-			•	•	•	
IN PATROL P.1. A.P.L. RIFLEMAN RIFLEMAN RIFLEMAN RATEIN/SECP 30 30 30 30 30 30 30 30 30 3	IN PATROL P.L. A.P.L. RIFLEMAN 30	ADUNDS REMAIN (MAG.)	02	20	20	20	20	20	0	0	0	!
SIGNMENT BASE FR. BAS	SIGNMENT BASE FR. BAS	FUNCTION IN PATROL	P.t.	A.P.L.	RIFLEMAN	RIFLEMAN		_				
STGNMENT BASE FR. BAS	STGNMENT BASE FR. BAS	MOVEMENT RATEIN/SECI	.30		.30		.30	.30	00.0	0.00	3.	ن ز
MMO SUPPLY 100 100 100 100 100 0 0 0 0 0 0 0 0 0	MMO SUPPLY 100 100 100 100 100 0 0 0 0 0 0 0 0 0	TADIA - ASSIGNMENT	BASE FR.	:	BASE FR.	1540	BASE	BASE				
FIRE TEAM 1 X = 1157-51 V = 1750-00 FIRE TEAM 1 X = 1157-51 V = 1750-00 FIRE TACKER MU 2 X = 1157-51 V = 1750-00 FIRE TACKER MU 2 X = 1157-51 V = 1750-00 FIRE TACKER MU 2 X = 1157-51 V = 1750-00 FIRE TACKER MU 2 X = 1157-51 V = 1750-00	FIRE TEAM 1 X = 1150.00 V = 1750.00	INITIAL AMMO SUPPLY	100		100				•	•	•	
FIRE TEAM 1 2 3 3 4 5 5 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	FIRE FEAM 1 2 3 3 4 5 5 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	JEAPON TVPE	AREA	AREA	AREA	AREA	•	_	i			i
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7.0 OPERATING PROCEDURES

This section describes the operating procedures in terms of hardware requirements, software requirements, overlay structure of the model, and sample deck setup.

7.1 HARDWARE REQUIREMENTS

- CDC 6000 series digital computer
- SCOPE operating system
- FORTRAN EXTENDED source program compiler (FTN)
- COMPASS assembler
- Tape drive for input of topocom tape
- 232K of octal 60-bit words central memory
- Temporary and short-term storage devices (i.e., disk or tape)
- Standard system file configuration for input data and object program modules.

7.2 SOFTWARE REQUIREMENTS

- FORTRAN unit 1 is used for reading namelist input data. This data consists of NAML1, NAML2, NAML3, and NAML4. File NLINP is referenced to this unit.
- FORTRAN unit 2 is used for temporary storage. At the beginning
 of the model the packed reconnaissance elevations are stored here.
 After the return of a combat operation this unit is read to restore
 reconnaissance elevation data. File PAKZ is referenced to this unit.
- FORTRAN unit 5 is used for standard input. File INPUT is referenced to this unit.
- FORTRAN unit 6 is used for standard output. File OUTPUT is referenced to this unit.
- FORTRAN unit 7 is used for temporary storage. When a start/stop
 point is reached, the common blocks are dumped or read from this unit,
 so that the model can be started or stopped at specific points. File
 START is referenced to this unit.
- FORTRAN unit 8 is used for reading elevation input data. This file is a direct output of topocom programs, MAPGEN or ROTATE. File ZINP is referenced to this unit.

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- FORTRAN unit 9 is used for intermediate storage. The common block STATS is updated on this unit for each replication of the model. File STATS is referenced to this unit.
- Most of the COMMON blocks used by the SIAF program are defined in the following computer pages 1 through 47 of Figure 7.1. These blocks were generated by the BLKGEN program described in Appendix A of this volume. Using these COMMON blocks the SPECPN program defined in Appendix B of this volume, punched out the DIMENSION and EQUIVALENCE statements for all subroutines requiring any variable pertaining to the COMMON blocks.
- Fo facilitate finding a location of a common variable, Figure 7.2 gives an alphabetical list of all variables in these commons. Furthermore, their location in that block and the block name are given along with its dimension if the variable is an array.

7.3 OVERLAY STRUCTURE

• Figure 7.3 is a chart overview of the overlay structure organization. Within each overlay block the overlay level is given and the subroutine and programs are listed alphabetically, along with the size of the model with that overlay.

7.4 SAMPLE DECK SET-UPS

- Figures 7.4 7.6 are listings of card decks that would be required to create the model from tane starting from scratch and end up with an execution of the sample case.
- Figure 7.4, when submitted, will create or copy from the SIAF tape, all source cards and store them on permanent disk file.
- Now, execution of Figure 7.5 will compile all these proceed cards and create the object modules required for loading. These also are stored on permanent disk files.
- Figure 7.6 takes the generated object modules along with the required input files and executes the sample case.

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7.5 INSTALLATION

• The SIAF program as described above was installed and runs on a CDC 6500 digital computer at the USACDC Data Processing Installation, at Fort Leavenworth, Kansas.

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Figure 7.1. Master Common Listings (Sheet 1)

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Figure 7.1. Master Common Listings (Sheet 3)

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Page	7-6

Figure 7.1, Master Common Listings (Sheet 4)

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Page	7-7	
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Figure 7.1, Master Common Listings (Sheet 5)

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Figure 7.1, Master Common Listings (Sheet 6)

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Figure 7.1, Master Common Listings (Sheet 7)

MASTER COMMON LISTING

COMMON/COMMBA/COMBA(903)

SURRENT COMMON IS --

4.204

DIMENSION

VARIABLE

Figure 7.1, Master Common Listings (Sheet 8)

MASTER COMMON LISTING

CURRENT COMMON IS -- CONNOL/CONNEL/CONNEL(715)
CURRENT BLOCK IS CONNEL (711)

(Sheet 9)
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Figure 7.1, Master Common Listings (Sheet 12)

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Figure 7.1. Master Common Listings (Sheet 13)

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Figure 7.1. Master Common Listings (Sheet 15)

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MASTER COMMON LISTING

COMMON/COMMB4/COMM44 (295)

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Figure 7.1, Master Common Listings (Sheet 16)

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Figure 7.1, Master Common Listings (Sheet 17)

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Figure 7.1. Master Common Listings (Sheet 21)	
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Figure 7.1, Master Common Listings (Sheet 22)

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Figure 7.1, Master Common Listings (Sheet 23)

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Page 7-26

	DESCRIPTION																										•						
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(243)	POSITION	110	111	112	113	116	115	122	123	154	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	0 7 7	141	142	163	7.7	145	146	167
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PAGE 24

4ASTER COMMON LISTING

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Figure 7.1. Master Common Listings (Sheet 26)

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	CURRENT COMMON IS	CURRENT BL	VARIABLE		0807	LOSA	LOST	ASOT

Figure 7.1, Master Common Listings (Sheet 27)

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Page	7-31	• • • • •																
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Figure 7.1. Master Common Listings (Sheet 30)

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Figure 7.3. Master Common Listings (Shapt 31)

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PAGE 34	POSITION TYPE DESCRIPTION
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MASTER COMMON LISTING	TYPE
200	POSITION
CURRENT BLOCK IS USTAR2	DIMENSION
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Figure 7.1. Master Common Listings (Sheet 34)

200				
	DESCRIPTION			
1S COMMON/USIBD3/USIBD3(265), USTAR3(200)	TYPE			
803/USIB03(26	POSITION	7 7 7	221 241	261
CURRENT COMMON IS COMMON USTB03/USTB03/265), USTAR3/2	DIMENSION	50.00	20	
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Figure 7.1. Master Common Listings (Sheet 35)

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CURRENT BLOCK IS USTARS (200)

Figure 7.1. Master Common Listings (Sheet 36)

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	TVPE DESCRIPTION					Master Common Listings (Sheet 37)	
USTB04/USTB04(500)	POSITION		•			Figure 7.1, M	
CURRENT BLOCK IS USIBUL 1 5001	VARIABLE DINENSION ISTAY 100.5						

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PAGE 36			
		DESCRIPTION	
MASTER COMMON LISTING	CURRENT BLOCK IS USIBOS (500)	TVPE	
1881	COMMON/USIBOS/USIBOS(500)	POSITION	
HON IS	CK IS USIBUS	DINENSION 100.5	
CURRENT COMMON IS	CURRENT BLO	VARIABLE	

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Figure 7.1. Master Common Listings (Sheet 38)

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PAG 19	Pag	e 7-41
		DESCRIPTION
MASTER CORROW LISTING		TYPE
•	(500)	POSITION
HON IS	COMMON/USTBO6/USTBO6 (500)	DIMENSION
CURRENT COMMON IS	CURRENT BL	VARIABLE

Figure 7.1, Master Common Listings (Sheet 39)

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CURRENT BLOCK	BLOCK IS USIBO7 (478)	867/USIB071480	07 (4 60) . USTAR4 (380)	(386)
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RCMIN	20	288		
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Figure 7.1. Master Common Listings (Sheet 40)

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CURRENT BLOCK IS USIBOT	DINEN	20		A0.11					,			
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Figure 7.1. Master Common Listings (Sheet 42)

MASTER COMMON LISTING

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		DESCRIPTION							Ė				Sheet 43)
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MASTER COMMON LISTING	808(10),USTAR5(1000)	TVPE	•			; ; ;					i		•
	808/USIBO8(10)		~ ~ M	4 W &								;	Figure 7.1,
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CURRENT BLOCK IS USTARS (1880)	VARIABLE DIMENSION XPLAM 100,5	
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Figure 7.1. Master Common Listings (Sheet 44)

Page 7-46

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Figure 7.1. Master Common Listings (Sheet 46)

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Figure 7.1. Master Common Listings (Sheet 47)

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Figure 7-2. Cross-reference of Common Variables (Sheet 1)

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COMMON VARIABLES IN ALPHABETICAL ORDER

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COMMON VARIABLES IN ALPHABETICAL PROER

SIAF,T100,MT1. TASK, TN=SIAF, TA=13954, OS=ATDSDPF, TR=TS. REQUEST, SIAFOO, *AM. REQUEST, SIAFO1, *AM. REQUEST, SIAFO2, *AM. REQUEST, SIAFO3, *AM. REQUEST, SIAFO4, *AM. REQUEST, SIAFOS, *AM. REQUEST, SIAFO6, *AM. REQUEST, SIAFO7, *AM. REQUEST, SIAFOB, *AM. REQUEST, BTPKS, *AM. REQUEST, NLINP, *AM. REQUEST, ZINP, *AM. REQUEST, CONVRT, *AM. REQUEST, MAPGEN, *AM. REQUEST, ROTATE, *AM. VSN,SIAF=0000. REQUEST, SIAF, *HY. COPYBR, SIAF, SIAFOO. COPYBR, SIAF, BTPKS COPYBR, SIAF, SIAFO1. COPYBR, SIAF, SIAFO2. COPYBR, SIAF, SIAF03. COPYBR, SIAF, SIAF04. COPYBR, SIAF, SIAFO5. COPYBR, SIAF, SIAFO6. COPYBR, SIAF, SIAFO7. COPYER, SIAF, SIAFO8.

Figure 7.4, Creation of Source Files (Sheet 1)

SKIPF, SIAF, 9. COPYBR, SIAF, NLINP. COPYER, SIAF, ZINP. COPYBR, SIAF, CONVRT. COPYBR, SIAF, MAPGEN. COPYBR, SIAF, ROTATE. CATALOG, SIAFOO, SIAFOO, ID=SIAF, RP=100, CY=1. CATALOG, BTPKS, BTPKS, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO1, SIAFO1, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO2, SIAFO2, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO3, SIAFO3, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO4, SIAFO4, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO5, SIAFO5, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO6, SIAFO6, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO7, SIAFO7, ID=SIAF, RP=100, CY=1. CATALOG, SIAFO8, SIAFO8, ID=SIAF, RP=100, CY=1. CATALOG, NLINP, NLINP, ID=SIAF, RP=100, CY=1. CATALOG,ZINP,ZINP,ID=SIAF,RP=100,CY=1. CATALOG, CONVRT, CONVRT, ID=SIAF, RP=100, CY=1. CATALOG, MAPGEN, MAPGEN, ID=SIAF, RP=100, CY=1. CATALOG, ROTATE, ROTATE, ID=SIAF, RP=100, CY=1. EOR EOI

Figure 7.4, Creation of Source Files (Sheet 2)

SIAF, T400. TASK, TN=SIAF, TA=13954, OS=ATDSDPF, TR=TS. REQUEST, NVBFTO, *AM. REQUEST, NVBFT1, *AM. REQUEST, NVBFT2, *AM. REQUEST, NVBFT3, *AM. REQUEST, NVBFT4, *AM. REQUEST, NVBFT5, *AM. REQUEST , NVBFT6 , +AM. REQUEST, NVBFT7, *AM. REQUEST, NVBFT8, *AM. ATTACH, SIAFOO, SIAFOO, ID=SIAF. ATTACH, BTPKS, BTPKS, ID=SIAF. ATTACH, SIAFO1, SIAFO1, ID=SIAF. ATTACH, SIAFO2, SIAFO2, ID=SIAF. ATTACH, SIAFO3, SIAFO3, ID=SIAF. ATTACH, SIAFO4, SIAFO4, ID=SIAF. ATTACH, SIAFO5, SIAFO5, ID=SIAF. ATTACH, SIAFO6, SIAFO6, ID=SIAF. ATTACH, SIAFO7, SIAFO7, ID=SIAF. ATTACH, SIAFO8, SIAFO8, ID=SIAF. FTN, I=SIAFOO, B=NVBFTO. COMPASS, I=BTPKS, B=NVBFTO.

Figure 7.5, Creation of Object Files (Sheet 1)

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FTN, I=SIAFO1, B=NVBFT1.
FTN, I=SIAFO2, B=NVBFT2.
FTN, I=SIAFO3, B=NVBFT3.
FTN, I=SIAF()4, B=NVBFT4.
FTN, I=SIAFO5, B=NVBFT5.
FTN, I=SIAFO6, B=NVBFT6.
FTN, I=SIAFO7, B=NVBFT7.
FTN, I=SIAFO8, B=NVBFT8.
CATALOG, NVRFTO, NVBFTO, ID=SIAF, CY=1.
CATALOG, NVBFT1, NVBFT1, ID=SIAF, CY=1.
CATALOG, NVBFT2, NVBFT2, ID=SIAF, CY=1.
CATALOG, NVBFT3, NVBFT3, ID=SIAF, CY=1.
CATALOG, NVBFT4, NVBFT4, ID=SIAF, CY=1.
CATALOG, NVBFT5, NVBFT5, ID=SIAF, CY=1.
CATALOG, NVBFT6, NVBFT6, ID=SIAF, CY=1.
CATALOG, NVBFT7, NVBFT7, ID=SIAF, CY=1.
CATALOG, NVBFT8, NVBFT8, ID=SIAF, CY=1.
EOR
EOI
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Figure 7.5, Creation of Object Files (Sheet 2)

SIAF, T700. TASK, TN=SIAF, TA=13954, OS=ATDSDPF, TR=TS. ATTACH, NVBFTO, NVBFTO, ID=SIAF. ATTACH, NVBFT1, NVBFT1, ID=SIAF. ATTACH, NVBFT2, NVBFT2, ID=SIAF. ATTACH, NVBFT3, NVBFT3, ID=SIAF. ATTACH, NVBFT4, NVBFT4, ID=SIAF. ATTACH, NVBFT5, NVBFT5, ID=SIAF. ATTACH, NVBFT6, NV9FT6, ID=SIAF. ATTACH, NVBFT7, NVBFT7, ID=SIAF. ATTACH, NVBFT8, NVBFT8, ID=SIAF. ATTACH, NLINP, NLINP, ID=SIAF. ATTACH, ZINP, ZINP, ID=SIAF. RFL,150000. LOAD, NVBFTO. LOAD, NVBFT1. LOAD, NVBFT2. LOAD, NVBFT3. LOAD, NVBFT4. LOAD, NVBFT5. LOAD, NVBFT6. LOAD, NYBFT7. LOAD, NVBFT8.

Figure 7.6, Execution of Model (Sheet 1)

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 $END
 SNAML 3
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SEND
SNAML4
         (REVISIONS TO NAMELIST NAML4)
SEND
EOR
103
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Figure 7.6, Execution of Model (Sheet 2)

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8.0 SIAF RELIEF MODEL VALIDATION

8.1 PURPOSE

The purpose of this discussion is to describe the method and results of simulating line of sight experiments to demonstrate the validity of:

1) the line of sight calculations; and 2) the mathematical concept of macro-relief representation in the SIAF Terrain Submodel. The raw data used in the simulation was taken from field measurements at nine different locations in the Hunter-Liggett Military Reservation. The experiment measures line of sight data with respect to macro-relief only; the effects due to vegetation and micro-relief features are neglected.

8.2 HUNTER-LIGGETT FIELD EXPERIMENT

8.2.1 Purpose

The primary purpose of the field experiment was to gather actual line of sight data concerning terrain macro-relief. The line of sight experiments were conducted at nine locations within the map section shown in Figure 8.1.

8.2.2 Equipment

The experiments required three pieces of equipment. A compass was used to determine direction, a one-hundred meter rope, graduated in five meter intervals was used to measure surface distance, and a pair of walkie-talkies was used to relay information.

8.2.3 Methodology:

The typical procedure undertaken is depicted in Figure 8.2. An observer would stand at an easily identifiable point (i.e., landmarks, roads, peaks, saddlepoints, etc.) with a compass and walkie-talkie. One end of the hundred-meter rope is held by the observer. Another individual, designated as the "target", moves away from the observer holding the other end of the rope. The target is also equipped with a walkie-talkie. The target continues to walk away from the stationary observer, until only the target's head is visible (to the observer) due to the interruption of the line of sight by the ground. The observer and target are in radio communication, so that the location of the target at the time of line of sight interruption is established accurately.

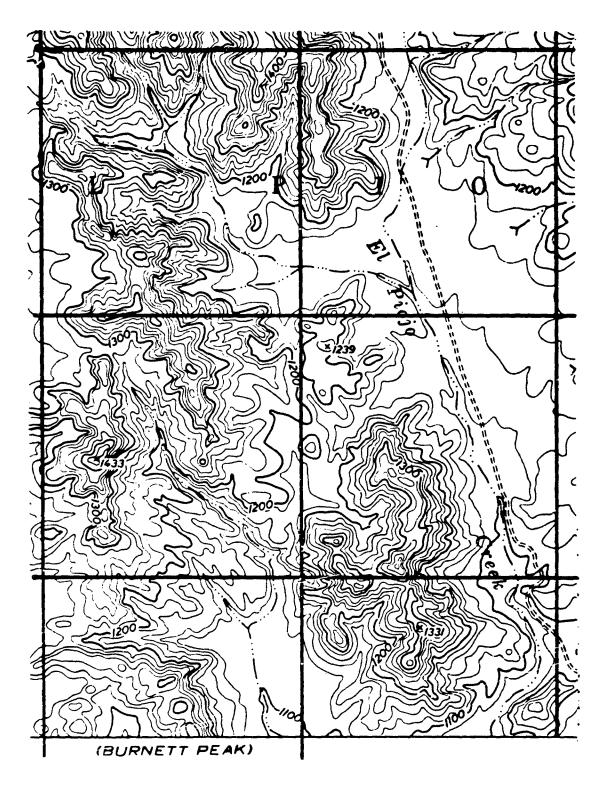


Figure 8.1, Hunter-Liggett Test Area



Figure 8.2, LOS Experimental Procedure

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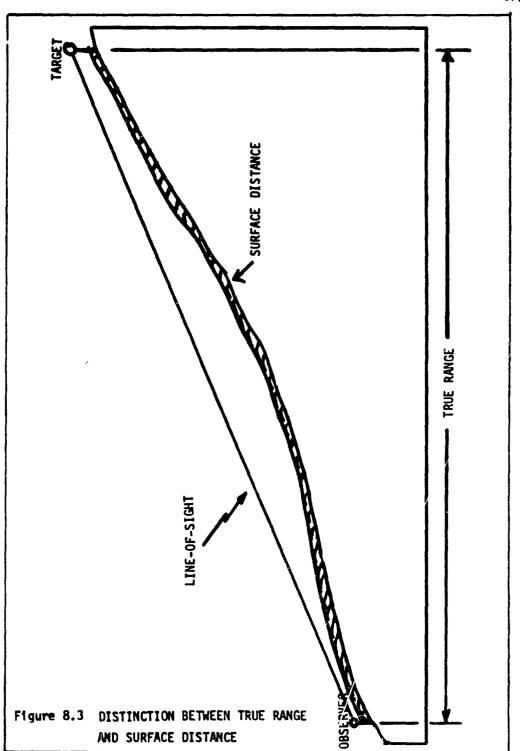
The procedure was repeated at approximately every fifteen degrees of arc, at which time a third individual would record the heading, and the "surface distance" between the observer and target. By "surface distance" we mean the distance traced out by the rope over the curvature of the ground. This is to be distinguished from the "range distance," which is the distance between observer and target when the line of sight is projected onto the grid plane of zero altitude. See Figure 8.3 for the distinction. This procedure continued over a three hundred and sixty degree sweep about the observer, whenever the terrain permitted.

Line of sight data was collected at nine different locations. At each site, several direction headings and the corresponding surface distances were recorded. The nine locations are shown in Figure 8.1, and the experimental data is displayed in Figure 8.4.

8.2.4 Field Measurement Errors

In conducting an experiment of this type, four sources of error are inherent and must be taken into consideration using the data for validation purposes.

- Location Error: Exact determination of the observer's position (grid coordinates) is impossible. Minimizing the effects of this type of error was achieved basically by choosing observer positions near relief landmarks such as roads, peaks, saddlepoints, and intersections.
- Compass Error: Compass readings are subject to errors due to alignment, sighting, and reading errors. An additional error source is in the estimation of magnetic north with respect to grid north. It is estimated that the combined effects of such errors amounts to ± 2° error.
- Linear Measurement Error: All distances recorded on a map are given for a grid plane (of zero altitude) normal to any given elevation. The experiment, however, was conducted around sloping, hilly areas. Thus, the measured distance between the observer and target is the sloping surface ("slant") distance, and will be in error as a function of the distance and the difference in elevation between them. An approximation



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	POINT 1	POINT 2	POINT 3	POINT 4	POINT S	POINT A	POINT 7	POINT 8	POINT 9
MEAS 1	25m, 40°	71m. 85°	24m, n°	310. 5*	27m,30°	fr. 115°	1/5m, 216*	65m, 1n0°	1396, 51
MEAS 2	71m, 115°	F5m,2F5*	29m, 40*	31m, 15*	28. E8.	6b. 125°	145a, 223*	Sm. 115	10th. 819
HEAS 3	50m, 300°	23m, 355*	. 55° - 492	35. 30°	28m. 108*	61a. 14gr	172. 229	67a. 136*	. X
NEAS 4			-8. ·8	35a, 40°	26m. 147*	8 . 38	196. 24	Mar. 152*	109. 116.
NEAS S			36s. 122°	66. 70°	4W. 180*	78. 15F		81m, 162"	18.18.
MEAS 6			47m. 132*	78.87	15. 171·	650, 165*		67a, 174*	116. 147
NEAS 7			35m, 180°	8	300. 252	13. 165°		57m, 185*	28. 166°
MEAS &			33m. 217*	5 . 10.	66. 231°	Str. 190*		57a. 205	356. 176.
NEAS 9			44m. 247*	376. 125*	250°				281a. 188°
NEAS 10			% 230°	78. 155°					137m. 203*
MEAS 11			SE. 256	25. 170°					10th, 215*
NEAS 12			¥6. 313°	47m. 240"					104m, 229*
MEAS 13			37B. 345°	3₺. 270					113e. 250°
MEAS 14				330.230					106m. 270°
NEAS 15				35a. 322"					1250. 279*
NEAS 16				35m, 350°					150m. 289°
MEAS 17									176m, 295"

Figure 8.4, Field Data (Hunter Liggett)

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of this type of error is given by $D_E^{-}D_M^{-}D_M^{-}$ Cos (0), where D_E^{-} is the error in the distance measurement, D_M^{-} is the actual measured distance, and 0 is the angle of elevation between observer and the target.

Vegetation: As stated earlier, the intent of the experiment was to validate the SIAF model using line of sight verdicts with respect to macro-relief only. The effects of vegetation on line of sight were ignored. However, the presence of grass, sometimes several feet in height, could have introduced error into the measurements. This type of error is dependent on the density and height of the grass. The distance at which the line of sight is lost tends to be less in the presence of grass than otherwise. The effect of this error was minimized by choosing observer locations having very little vegetation (grass having negligible height) whenever possible.

8.3 ELEMENTS OF SIAF MODEL USED IN VALIDATION

8.3.1 Mathematical Representation at Macro-Relief in SIAF Model

The SIAF model utilizes a grid concept to describe macro-relief. Within each grid square a continuous surface is mathematically represented by a quadratic surface weighting all four corner elevation points. A region under consideration is assumed to be sufficiently small, so that effects due to earth's curvature are neglected, (i.e., a flat earth assumption is made, allowing use to use surface altitudes given by topographical maps). At each grid point, the earth's surface is specified by its altitude. Altitude data is available for grid resolutions as fine as 12.7 meters. The surface at nongrid points are determined as a weighted average of the four altitudes at the corner points of the grid square in which the point lies.

Consider Figure 8.5. Grid lines are defined by

$$x_j = (j-1)\Delta x$$

 $y_k = (k-1)\Delta y$

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where Δx and Δy are grid square dimensions. The j, kth rectangle is bounded by the grid lines $\{x=x_j, y=y_k, x=x_j+1, y=y_k=1\}$. The surface within the j, kth grid square, as shown in Figure 8.5, is determined in the following manner where $z_{j,k}$, $z_{j,k+1}$, $z_{j+1,k}$ and $z_{j+1,k+1}$ are the input

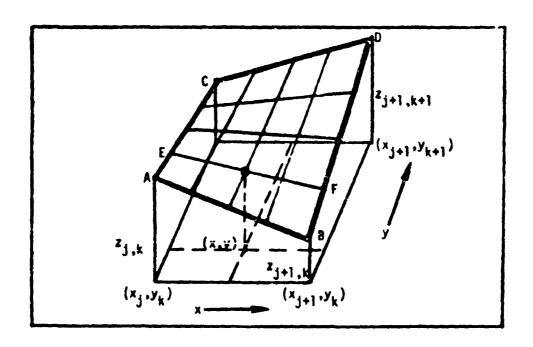


Figure 8.5, Surface Within j.kth Rectangle

altitudes of the four corner points:

Altitude on Line AB:
$$z_k(x) = \left[z_{j,k} + \frac{x-x_j}{x_{j+1}-x_j} (z_{j+1,k}-z_{j,k}) \right]$$

Altitude on Line CD:
$$z_{k+1}(x) = \left[z_{j,k+1} + \frac{x-x_j}{x_{j+1}-x_j} (z_{j+1,k+1}-z_{j,k+1}) \right]$$

Altitude on Line EF (weighted average):

$$z(x,y) = \left\{ z_k(x) + \frac{y-y_k}{y_{k+1}-y_k} [z_{k+1}(x)-z_k(x)] \right\}$$

8.3.2 SIAF Subroutines Used

The subroutine LOSVEG is responsible for the line of sight calculations in the SIAF model. This subroutine is called by the subroutine DETERR. DETERR calculates intervisibility between any pair of points on the terrain for prone and upright positions of both the observer and the target. This intervisibility is characterized in terms of line of sight obstructions and various probabilities of cover and concealment. Cover and concealment are provided by micro-relief features and vegetation. Since the purpose of the field experiment was to consider macro-relief only, the line of sight experiments were performed in areas characterized by little or negligible amounts of micro-relief objects and vegetation. Thus the effects of cover and concealment on intervisibility are neglected in the simulation, and DETERR was modified to do this. Furthermore, for each pair of points on the terrain locating the observer and target, four lines of sight are considered by the subroutine DETERR.

- 1) "Head to head", i.e., observer and observed both upright.
- 2) "Head to foot", i.e., observer upright and observed prone.
- 3) "Foot to head", i.e., observer prone and observed upright.
- 4) "Foot to foot", i.e., observer and observed both prone.

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Since the field experiments considered only "head to head" lines of sight, DETERR was modified such that the simulation considered only that case.

The primary purpose of LOSVEG is to determine if the line of sight between an observer and target is obstructed by the intervening land surface (macro-relief). It accomplishes this by projecting the line of sight onto a grid plane (of zero altitude). Every intersection of the line of sight with horizontal and vertical grid crossings partitions the line of sight into segments. The subroutine checks for line of sight interruptions within or at the end-point of a given segment. This is done segment by segment, beginning with the segment containing the observer's position, until the line of sight is interrupted. If no interruption occurs the fraction of target height and the fraction of observer height covered by macro-relief is calculated; the routine continues on to compute cumulative distance through vegetation. It checks to see whether the cumulative distances through certain vegetation feature types is great enough to cause concealment of the target. This cumulative vegetation check, however, is of no concern to this test.

Detailed documentation and flow charts of LOSVEG and DETERR can be found in Volumes II and V respectively of the SIAF Users Manual.

8.4 COMPUTER SIMULATION OF FIELD TEST

The subroutines discussed above were modified and inserted into a program designed to simulate the line of sight experiments conducted at Hunter Liggett. The program considers only macro-relief features; it also takes into account several of the error sources which were inherent in the field experiments.

8.4.1 Simulation Methodology

The basic simulation procedure tries to model the actual experimental procedure conducted in the field. A given observer's position (grid coordinates on a topographic map) is determined as accurately as possible. Based on this determination, the program reads in all the elevation data in a square area centered about this point. The area is 444.5 grid points (using 12.7 meter resolution).

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As in the actual experiments, the target is programmed to move away from the observer in a fixed direction. The target steps off increments of 3.175 meters away from observer. Every step increment initiates a call to subroutine DETERR, which in turn, calls LOSVEG to determine if a "head-to-head" line of sight exists. If it does the target takes another step of 3.175 meters away from the observer. The line of sight routine is called again. The procedure is repeated as long as the line of sight exists. This continues until either the line of sight no longer exists due to macro-relief obstruction, or the target has stepped off so many increments away from the observer that elevation data is no longer available for line of sight calculations. In the latter case, the distance between the observer and the target for which line of sight remains uninterrupted by macro-relief is considered to be unlimited.

Once the line of sight is obstructed, the target is programmed to move towards the observer. The step increment is reduced by half to 1.5875 meters. Again, each step increment initiates a call to the appropriate subroutines giving a line of sight verdict. The target is programmed to continue the inward movement until an uninterrupted line of sight is established again. As soon as the line of sight has been re-established, the target begins moving away from the observer once more. Now the step increments are made smaller (1.5875+2). As before, each step gives rise to a line of sight verdict. The target continues moving away from the observer until the line of sight is interrupted by macrorelief again. At this instance, the range between the observer and target is recorded. In addition, the ranges between the observer and the line of sight intersections with grid crossings are recorded. These distances are needed to form an approximation of the actual surface between the observer and target. In short the simulation obtains data to approximate the surface distance by pinpointing the target's exact location (in a forward and backward manner) at the instant of line of sight obstruction.

The surface distance approximation is required because LOSVEG projects all lines of sight onto a grid plane of zero altitude, and computes all distances on this plane. Naturally, for extremely undulating relief, the linear range computed would be a poor approximation of the actual surface

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distance measured at Hunter Liggett. Figure 8.6 illustrates the estimation procedure. The distance between two successive grid crossings is computed. This is done for the C^{th} grid line by subtracting D(C) from D(C+1). The elevations at points where the line of sight intersect the two grid crossings are computed also (ZZZ(C+1), and ZZZ(C)). The difference in elevation at these two points can be computed by subtracting ZZZ(C) from ZZZ(C+1). The surface distance from the C^{th} line is the length of the hypotenuse of the right triangle having sides |D(C+1)-D(C)| and |ZZZ(C+1)-ZZZ(C)|. The estimation procedure is repeated for all grid squares having intersections with the line of sight; the results are summed to produce the surface distance from observer to target.

8.4.2 A Measure for Evaluating Validity

A comparison is made between the actual surface distance measured in the field and the estimated surface distance produced by the simulation. The absolute value of the difference between the actual and simulated surface distances is computed. This difference provides a measure for evaluating the credibility of:

- 1) the line of sight calculations and
- 2) the mathematical representation of macro-relief.

Specifically, a difference that approaches zero indicates that the simulation is producing reasonable results. However, a very small difference, or a difference of zero should not be interpreted as evidence of complete validity. It merely reflects that the line of sight algorithm, and the mathematical model for relief give reasonable estimates of the true situation.

8.4.3 Error Adjustments

Recall that the raw data from the field experiments was subject to four basic types of error. One such error involved inaccuracies in pin-pointing the exact location of the observer on a topographical map.

A pencil point on a map of scale 1:50000, can be in error by as much as 20 meters. Furthermore, the exact location of the target is in doubt, not only due to the uncertainties in the observer's location, but due to

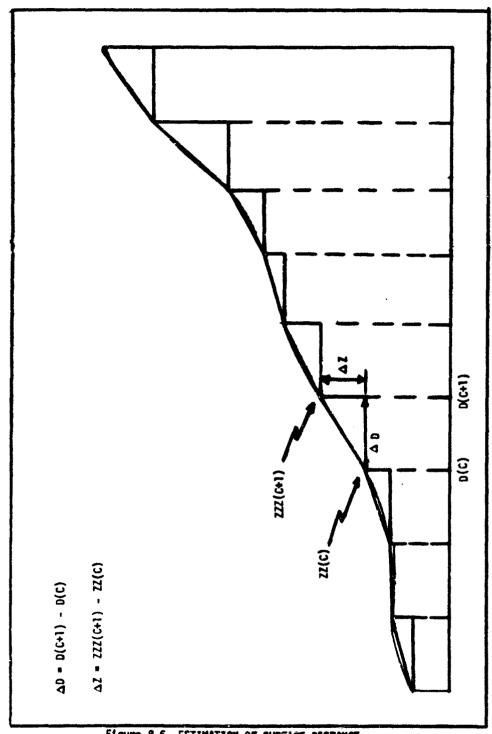


Figure 8.6 ESTIMATION OF SURFACE DISTANCE

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compass errors. The computer simulation attempts to correct such errors by:

- 1) considering a set of observer locations; and
- 2) slightly perturbing the angle of direction which locates the target relative to the observer.

Instead of investigating one possible observer location, the simulation considers a set of possible locations. Thirty-six equally spaced points within a 12.7 by 12.7 square area are analyzed. Each point is 2.54 meters apart. Thus, the input for "observer location" is not given by a pair of coordinates denoting a single point; it is given by a small grid area enclosing the most likely observer location. See Figure 8.7. This technique removes the guesswork involved with measuring map coordinates (by hand with a ruler), and places more emphasis on locating the observer's position relative to his immediate macro-relief environment.

At every observer location at Hunter Liggett, line of sight data was gathered in several different directions. The recorded angle (relative to magnetic north), for a given direction will be designated the "base angle." This angle contains small uncertainties due to compass reading errors. The simulation attempts to eliminate these uncertainties by perturbing the base angle slightly $(\pm 1^{\circ})$ and $\pm 2^{\circ}$. Thus, five different line of sight determinations are performed for a given direction:

- 1) the base angle determination;
- 2) base angle +2°;
- 3) base angle +1°;
- 4) base angle -1°; and
- 5) base angle -2°.

In each case, the absolute value of the difference between actual and simulated surface distance is computed. The angle resulting in the smallest difference is chosen as the new "base angle" for that given direction. The same procedure is applied to each of the several other directions recorded at the experiment site.

In most instances, the simulation examined only three recorded directions at each experiment site. These three directions were chosen arbitrarily, but remained the same for each of the thirty-six points at

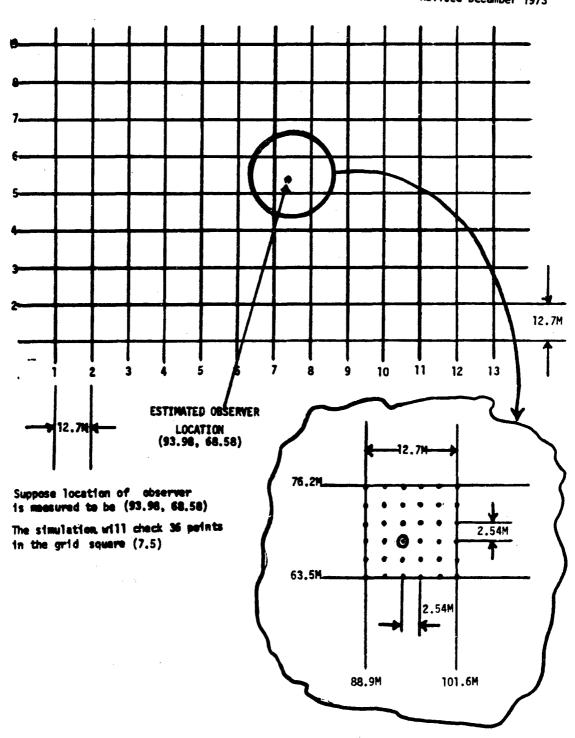


Figure 8.7 GRID OR OBSERVER LOCATION

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a given location. Computer costs involved with examining more than three directions were prohibitive: the simulation considers thirty-six points. If three directions are examined, then fifteen line of sight experiments are performed (3x5). Thus there are 36x15=360 line of sight experiments performed for one location at Hunter Liggett.

8.4.4 Overall Measure of Validity

Recall that the absolute difference provided a measure of validity for a line of sight experiment conducted in <u>one</u> direction. But for each point, <u>three different directions</u> were analyzed. Thus a summary statistic, measuring the accuracy of line of sight calculations for all three directions, was needed.

The root mean square of the difference in each direction was chosen to measure the accuracy of all line of sight calculations at a given point. Specifically, the quantity measuring overall validity for line of sight calculations in all directions is given by:

$$\sqrt{\sum_{I=1}^{N} \{D_{A}(I)-D_{C}(I)\}^{2}}, \text{ where } D_{A}(I) \text{ is the actual}$$

surface distance in the I^{th} direction, $D_{C}(I)$ is calculated surface distance in the I^{th} direction, and N is the number of directions analyzed (N=3 in this simulation). Thus every one of the thirty-six possible points under consideration has associated with it, a root mean square difference. This number reflects the accuracy of the simulation experiments at each of these points. The location of the point having the least root mean square difference is chosen to represent the actual position of the observer in the field experiment.

8.4.5 Simulation Using Different Resolutions

The simulations were conducted using three grid size resolutions. The initial simulation was done with elevation data available at grid points 12.7 meters apart. This was the finest resolution of elevation data available; hence this resolution was used to locate the actual

positions of the observer at the experiment sites. Having established these locations, the simulation was performed using coarser resolution: elevation data points 25.4 and 50.8 meters apart respectively. The simulation procedure using cruder resolution is exactly the same as described above, except that it no longer examines the set of thirty-six possible points for an actual location (it uses the actual locations derived from the initial simulation, thus avoiding a great deal of processing).

8.5 ANALYSIS OF SIMULATION RESULTS.

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The root mean square (of differences between actual and simulated surface distance in all line of sight directions examined for a given experiment site at Hunter Liggett) provides a measure for evaluating the validity of the line of sight routines and macro-relief representation. Figure 8.8 gives these measures for all nine Hunter Liggett experiment sites, at the various resolutions used in the simulation. Figure 8.9 presents the simulation results broken down into individual line of sight experiments. The overall root mean square difference is given on this figure also.

As Figure 8.8 indicates, the simulation performed under 12.7 meter resolution produce very credible results. The results using 25.4 and 50.8 meter resolution are credible, but not as sharp. The reason for this is that the line of sight interruption distances measured are relatively short (i.e., with respect to the length of the side of the grid squares). Many of the line of sight obstruction distances measured at Hunter Liggett were less than 100 meters in length. These short distances do not affect the simulation when the resolution is very fine (i.e., 12.7 meter resolution), but as the resolution becomes coarser, the simulation results are more inaccurate. It must be stressed that this happens only when simulation is attempted over very short lines of sight using very coarse resolution. The inaccuracies appear in the form of large root mean square differences. Coarse resolution should be used in line of sight determinations when the observer and target are over 200 meters away.

SUTE	12.7 METERS	RESOLUTION	25.4 METERS	RESOLUTION	50.8 METER	S RESOLUTION
	ROOT MEAN SQUARE	PERCENT	ROOT MEAN SQUARE	PERCENT	ROOT MEAN SQUARE	PERCENT
1	5.9M	10.6	8.214	42.7	67.8M	107.0
2	1.7M	3.3	18.6M	50.0	11.5M	43.0
3	1.6M	4.0	4.7M	40.6	•	100.
4	0.34	0.5	4.7M	12.3	39.0M	107.2
5	2.1M	5.0	24.6M	82.8	38.9M	105.9
8	2.7M	4.6	10.0M	13.7	31.0M	52.8
7	8.1M	4.9	40.1M	25.9	67.7M	62.9
8	9.1M	9.7	16.0M	19.7	39.6M	71.8
9	3.0M	1.7	22.6M	12.1	48.1M	52.3

^{*} UNLIMITED LINE OF SIGHT (i.e., TARGET HAS STEPPED OFF SO MANY INCREMENTS FROM OBSERVER THAT ELEVATION DATA IS NO LONGER AVAILABLE FOR LOS CALCULATIONS). FIGURE 8.10 ILLUSTRATES HOW THIS CAN HAPPEN.

FIGURE 8.8 ROOT MEAN SQUARE ERROR AT DIFFERENT RESOLUTIONS

	!	DIREC	100 1	DIE!	11CH 2	DIREC	710N 3	
SETE	RESOLUTION	MEASURED DISTANCE	ERROR	ELONED DISTANCE	EPAOR	MEASURED DISTANCE		NOOT MEAN SQUARE
	12.7		1.8		6.3		7.8	5.9
1	25.4	25.	•	π.	6.8	50.	9.3	8.2
	50.8		•		25.3		92.	67.8
	12.7		1.9		2.2		9	1.7
2	25.4	n.	-4.2	65 .	25.	23.	•	18.6
	8,0		-15.6		4,5		•	11.5
	12.7		.9		4		-2.6	1.6
3	28.4	26.		.	1.1	36.	6,5	4.7
	8.02		•		•		•	•
	12.7		.0		3		.3	0.3
4	25.4	36.	-6,8	а.	3,2	47.	-3.0	4.7
	50.8		•		50.1		-23.0	39.0
	12.7		-3,6		.0		.7	2.1
5	25.4	27.	٠	28.	30,6	42.5	-16.6	24,6
	50.8		•		55,		9.0	38.9

*Unlimited Line of Sight (i.e., target has stepped off so many increments from observer that elevation data is no longer available for LOS calculations). Figure 8.10 illustrates how this can happen.

Error = $D_{\mathcal{C}}(I)$ - $D_{\mathcal{A}}(I)$ where $D_{\mathcal{C}}(I)$ is the calculated surface distance in the I^{th} direction and $D_{\mathcal{A}}(I)$ is the actual measured surface distance in the I^{th} direction.

Figure 8.9, Detailed Simulation Results (Skeet 1)
(ALL MEASUREMENTS IN METERS)

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		DIRECT	100 1	DIREC	TION 2	DIRECT	TION 3	
SITE	RESOLUTION	MEASURED DISTANCE	ERROR	MEASURED DI STANCE	ERROR	MEASURED DISTANCE	ERROR	NOOT HEAM SQUARE
	12.7		-1.8		-3.7		-2.4	2.7
6	25.4	61.	-14,5	61.	-9.3	49.	1.0	10.0
	50,8		-33.5		-35.8		-21.9	31.0
	12.7		11.4		5.3		-5.2	8.1
7	25.4	145.	₩.0	145.	50.8	172.	27.0	49.1
	\$0.8		43,3		85.4		•	4 7.7
	12.7		-10.5		-11.8		.0	9.1
	25,4	67.	-10.1	.	-24.0	57.	9.5	16.0
	50.8		٠		38.0		41.2	39,6
	12.7		.6		5.1		.5	3.0
•	25.4	139.	-12.9	118.	-1.1	152.	40.	22.6
	50.8		-67,4		1.8		•	48.1

*Unlimited line of sight (i.e., target has stepped off so many increments from observer that elevation data is no longer available for LOS calculations). Figure 8.10 illustrates how this can happen.

Error = $D_C(I)$ - $D_A(I)$ where $D_C(I)$ is the calculated surface distance in the I^{th} direction and $D_A(I)$ is the actual measured surface distance in the I^{th} direction.

Figure 8.9, Detailed Simulation Results (Sheet 2)

(ALL MEASUREMENTS IN METERS)

Figure 8.10 demonstrates what can happen when line of sight calculations are conducted over a short distance using various resolutions. An observer and target, both of height 1.8 meters, stand 12 meters apart. Macro-relief described with 12.7 meter resolution indicates a line of sight interruption at approximately 6.7 meters from the observer. However, no such line of sight interruption occurs when describing macro-relief with 25.4 or 50.8 meter resolution. The figure shows that the hump at about 6.7 meters from the observer is not modeled when describing macro-relief using the cruder resolutions. This explains why some of the root mean square differences are so large when the simulation was run using 25.4 and 50.8 resolution (recall that the target keeps moving away from the observer until a verdict of obstruction is given).

The simulation results particularly those obtained when using the 12.7 meter resolution demonstrate that the SIAF line of sight routine and the SIAF representation of macro-relief are "reasonable". Furthermore, line of sight calculations are sensitive to resolution when the distance between observer and target is small (i.e., less than 100 meters). For the reason, the SIAF concept of switching resolution (using less resolution in the Reconnaissance Mode when long distances are involved; and finer resolution in the Combat Mode when shorter distances are involed, and more detailed computation are required) appears well founded.

8.6 SUMMARY

Line of sight data was collected at nine different locations at the Hunter Liggett Military Reservation. At each location, line of sight experiments were conducted in several different directions. Inherent errors in compass reading and in locating positions on a topographical map required the simulation to consider a set of possible locations and to vary the directions between observer and target. The initial simulation examines a set of thirty-six equally spaced (2.54 meters apart) points enclosed in a 12.7 by 12.7 meter grid square. Each of the thirty-six points are analyzed as follows. Three arbitrary experimental directions were chosen. Each direction is perturbed by $\pm 1^{\circ}$ and $\pm 2^{\circ}$, so that five line of sight verdicts are obtained. The verdict which offers the minimum

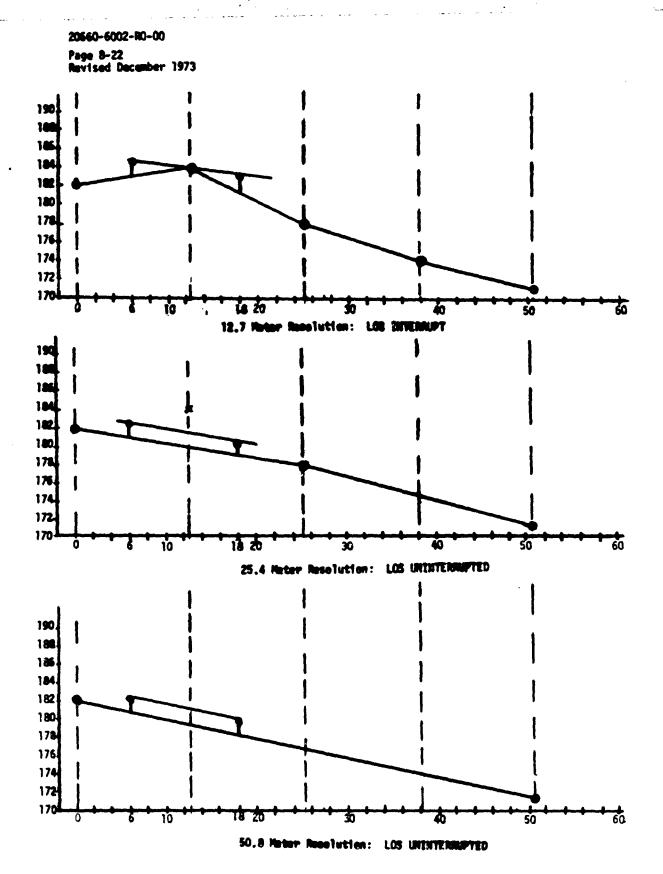


Figure 8.10 LOS VERDICT USING DIFFERENT RESOLUTIONS

difference between actual and computed surface distance determines the base angle for that direction. Thus each direction has associated with it, a measure of how accurate the simulation was. The root mean square of these individual differences gives an over measure of how accurate the simulation of the field experiment was at that point. The root mean square difference is given by:

$$\sqrt{\frac{\sum_{i=1}^{N} \{D_{A}(i)-D_{C}(i)\}^{2}}{N}}$$

where $D_A(I)$ is the actual surface distance, $D_C(I)$ is the computed surface distance, and N is the number of directions analyzed.

The initial simulation examines thirty-six possible points for a given experiment location, thus producing thirty-six root mean square differences. The location of the point having smallest root mean square is considered the site where the line of sight experiment actually took place. All nine experiment sites at Hunter Liggett were determined by the above procedure.

The simulation was repeated using resolutions of 25.4 and 50.8 meters. The same procedure was applied, except the observer positions are inputted (from initial simulation) instead of calculated.

The results of the simulation demonstrate that the SIAF line of sight calculations and the SIAF model of macro-relief are valid. Also, when the distance between observer and target is small (i.e., less than 100 meters), the line of sight calculations are dependent on resolution.

8.7 COMPARISON WITH ASARS BATTLE MODEL

Macro-relief models usually employ a grid square concept in which elevation data is known at four corners of each grid. The elevation at points lying between these data points are represented by an interpolated value using the known data points. Different methods are used to obtain these interpolated values. As mentioned before, the STAF model uses a continuous

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surface representation within a grid square based on the four surrounding grid points. A less complex method uses two intersecting triangular planes within a grid square to obtain interpolated values. This scheme is used in the ASARS model. The simulation experiment was done utilizing both representations of macro-relief; the results were compared.

8.7.1 ASARS Methodology

ASARS macro-relief is modeled by specifying two triangular planes within a grid square. The planes are defined by specifying a diagonal within the grid square (a positive diagonal if it connects the lower left corner with the upper right corner; a negative diagonal if it connects the upper left corner with the lower right corner). The orientation of the diagonal is the same for all grid squares under consideration. Positive diagonals were used in the simulation.

The line of sight subroutine in the ASARS model is basically a series of comparisons. The line of sight between the observer and the target is projected onto a grid plane (of zero altitude) and partitioned into a set of segments. The endpoints of these segments are defined by the intersection of the line of sight with horizontal and vertical grid crossings and with diagonals. Initially, the horizontal distance between observer and target, and the vertical difference in elevation between the top of the observer and the top of the target are computed. These quantities are used to compute the tangent of the angle subtended by the line of sight and a horizontal line parallel to the grid plane at the top of the observer. This tangent value is designated "TANLIM".

The line of sight routine proceeds as follows: the elevation of the ground surface at an endpoint of a segment is referenced. The horizontal range from the observer to the endpoint is computed. These quantities are used to compute the tangent of the angle subtended by the line extending from the top of the observer to the ground surface at that endpoint, and the horizontal line parallel to the grid plane at the observer's height. Call this quantity "TAN". Figure 8.12 illustrates the above procedure. A comparison is made between TANLIM and TAN, to determine the line of sight verdict: If TAN is greater than or equal to TANLIM, the line of sight is interrupted at that endpoint. Otherwise, the line of sight exists and the

		DIR	ECTION	1	DIR	ECTION	2	DIR	CTION	3		
SITE	RESOLUTION	MEAS. DIST.	SIAF ERROR		MEAS. DIST.		ASARS Error	MEAS.		ASARS ERROR		ASARS R.M.S.
	12.7		1.8	1.4		6.3	5.3		7.8	*	5.9	3.9
1	25.4	25.	•	•	71.	6.8	. •	50.	9.3	94.9	8.2	94 .9
	50.8		•	٠		26.3	•		92.	189.2	67.8	189.2
	12.7		1.9	.9		2.2	-2.7		9	1.6	1.7	1.9
2	25.4	71.	-8.2	-3.0	65.	25.	- 172.0	23.	•	٠	18.6	121.8
	50.8		-15.6	175.3		4.5	171.0		٠	٠	11.5	173.2
	12.7		.9	15.		4	5.8		-2.6	9.8	1.6	10.9
3	25.4	26.	•	131.6	29.	1.1	٠	36.	6.5	•	4.7	131.6
	50.8		•	69.7		. •	•		•	٠	٠	69.7
	12.7		.0	7.0		3	-6.1		.3	.5	.3	5.4
4	25.4	35.	-6.8	182.7	29.	3.2	201.4	47.	-3.0	179.1	4.7	188.0
	50.8		•	٠		50.1	201.5		-23.0	178.4	39.0	190.3
	12.7		-3.6	-2.4		.0	-4.7		.7	-10.2	2.1	6.6
5	25.4	27.	٠	٠	28.	30.6	٠	42.5	-16.6	٠	24.6	131.6
	50.8		•	•		55.	104.8		9.0	170.7	38.9	141.6

^{*} UNLIMITED LINE OF SIGHT (i.e., TARGET HAS STEPPED OFF SO MANY INCREMENTS FROM OBSERVER THAT ELEVATION DATA IS NO LONGER AVAILABLE FOR LOS CALCULATIONS). FIGURE 8.10 ILLUSTRATES HOW THIS CAN HAPPEN.

FIGURE 8.11 SIAF AND ASARS SIMULATION RESULTS (SHEET 1)
(ALL MEASUREMENTS IN METERS)

ERROR = $D_C(I)$ - $D_A(I)$ WHERE $D_C(I)$ IS THE CALCULATED SURFACE DISTANCE IN THE ITH DIRECTION AND $D_A(I)$ IS THE ACTUAL MEASURED SURFACE DISTANCE IN THE ITH DIRECTION.

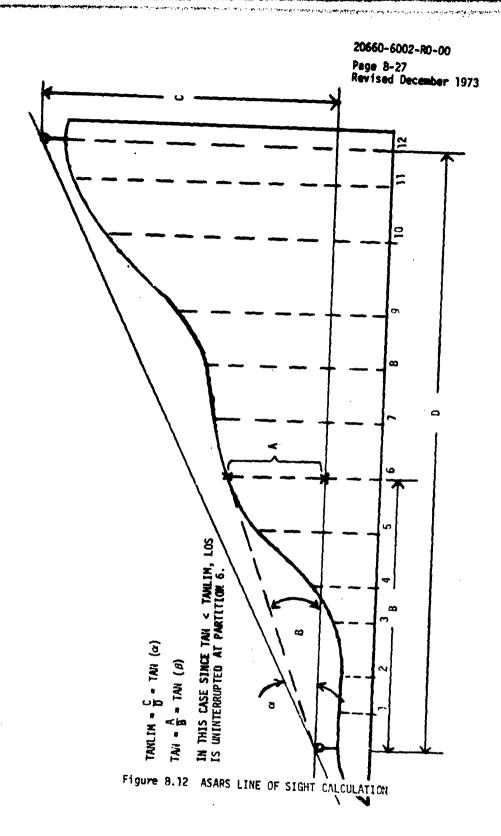
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SETE	MESOLUTION	236. 237.	SIA	成都 Date	NEAS. DEST.	SLAF EDGER	MARS E PROP	MEAS. DIST.			STAF R.H.S.	
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•	25.4	67.	14.5	32.5	67.	-9.3	31.1	49.	1.0	96.9	10.0	62.7
	59.8		33.5	39.3		35.8	60.7		-21.9	·	31.0	130.
	12.7		11.8	-35.7		5.3	-37.3		-5.2	•	8.1	36.5
7	25.4	146.	39.0	112.9	146.	39.8	20.9	172.	27.0	26.7	40.1	68.1
	39.8		43.3	36.2		85.4	66.4		•	29.2	67.7	65.0
	12.7		-10.5	2.5		-11.8	15.5		.0	٠	9.1	11.1
	25.4	67.	10.1	21.9	₩.	-24-0	.9	57.	9.5	64.2	16.0	39.2
	39.3		٠	45.1		30.0	₩.0		41.2	22.7	39.6	20.
	12.7		.6	60.		5.1	٠		.5	61.0	3.0	55.7
	25.4) 39 .	-12.9	30.3	18.	-1.1	943.4	152.	40.	•	22.6	137.0
	56.8		67.4	212.		9.8	144.3		•	•	40.1	181.3

^{*} UNLIMITED LINE OF SIGHT (1.6., TARGET HAS STEPPED OFF SO MANY INCREMENTS FROM OBSERVER THAT ELEVATION DATA IS NO LONGER AVAILABLE FOR LOS CALCULATIONS). FIGURE 8.10 ILLUSTRATES HOW THIS CAN HAPPEN.

ERROR = $D_C(U)$ - $D_A(I)$ where $D_C(I)$ is the calculated surface distance in the I^{TH} direction and $D_A(I)$ is the actual measured surface distance in the I^{TH} direction

FIGURE 8.11 SIAF AND ASARS SIMULATION RESULTS (SHEET 2)

(ALL MEASUREMENTS IN METERS)



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procedure is repeated at the next endpoint.

The above procedure starts at the observer position and continues toward the target, until line of sight interruption occurs. If no interruption occurs, the fraction of target height covered by intervening macrorelief is computed.

The ASARS method of representing macro-relief along with the ASARS line of sight routine were inserted into the simulation program. Appropriate minor modifications in the simulation program were made to accommodate the change. Otherwise, the exact methodology used in the SIAF macro-relief simulation was followed for the ASARS simulation.

8.7.2 Comparison

The simulation results using the ASARS macro-relief model did not compare as well as those of the SIAF simulation. The ASARS simulation produced credible results at 12.7 meters resolution. As figure 8.11 indicates, the SIAF results at this resolution were generally better than those returned by the ASARS method (though in some instances the ASARS method gave better approximations). At coarser resolutions (25.4 and 50.8 meters), the SIAF results were significantly better. In almost every instance, the SIAF simulation gave smaller errors, and thus smaller root mean square differences. Also, the ASARS simulation produced more instances where erroneous "unlimited" lines of sight were given (see figure 8.10 for explanation).

The large root mean square differences at the coarser resolutions may be attributed to the less accurate scheme for approximating macro-relief. Intepolated values in the SIAF model use data from all four surrounding grid points, whereas the ASARS model use only three of the four data points available. In addition, the ASARS relief model has the disadvantage that the choice of which grid square diagonal to use in forming the two triangular planes must be held constant throughout the entire gridded area under consideration. This disadvantage results in a loss of realism (this method does not give a unique representation of relief). A situation depicted in figure 8.13 illustrates this disadvantage. In both case 1 and case 2, the same set of four data points is input. Suppose case 2 is the desired approximation (ridge), but because positive diagonals (lower left corner to upper right corner) was the established choice of diagonal orientation, we

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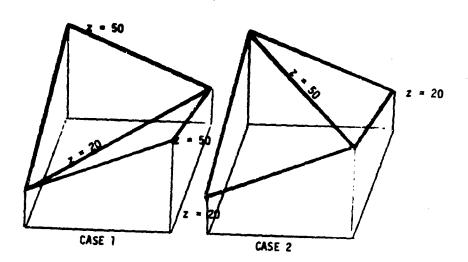


Figure 8.13 Non-Unique Terrain Surface Representation

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obtained an inaccurate representation (ravine). Clearly, the two surfaces resulting are quite different depending on the choice of diagonals. Thus, in comparison, it appears that the two-triangular-plane method of ASARS requires a smaller grid size to represent macro-relief to the same resolution as the four-point continuous surface scheme of SIAF.

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9.0 REFERENCES

- S. Q. Duntley, et al, "Visibility," <u>Applied Optics</u>, Volume 3, Number 5, May 1964.
- 2. "Training for SIAF, Program Description Number 1: Land Navigation," HumRRO Division 4.
- 3. Army Map Sheets, Numbers 1755 IV NE, 1755 I NW, 1755 IV SE, and 1755 I SW, for Alder Peak, California, 1:25,000.
- TRW Systems Group, "SIAF Model Development, Validation, and Implementation Final Report," 16905-6012-R0-00.

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APPENDICES

Included herein are Appendix A, Block Data Generator Program and Appendix B, Specification Statement Punch Program (SPECPN) User's Guide.

These Appendices describe two computer programs which were originally written for the IBM 7094. These programs have recently been modified to run on the IBM 360, and in the process an additional change has been made.

The main external difference in the programs is that BLKGEN no longer punches a BLOCK DATA subprogram which must be input to SPECPN. The necessary information is written on tape and is read back directly into the necessary COMMON blocks for SPECPN. This eliminates the need for two separate passes through the machine, since the two programs can be run as one single program. They can, however, be run as separate phases if necessary, using a previously generated tape as input to SPECPN.

The conversion to the 360 was handled in this manner for several reasons:

- It eliminated the need for unnecessary card handling associated with a punched BLOCK DATA.
- It eliminated the need for two separate passes through the machine, since there is no need to compile a BLOCK DATA subprogram, and thus improved turnaround.
- 3. It improved the running time of the program by eliminating the punching of the BLOCK DATA.

The inputs to both BLKGEN and SPECPN remain unchanged from those described in Appendix A and Appendix B. The 360 version can thus be run using existing decks with no modifications. However, since the programs have been combined utilizing a short driver, an additional control card is necessary to specify whether BLKGEN, SPECPN, or both are to be executed. This control card must precede all other data. Card column 1 is punched non-zero if it is desired to execute BLKGEN; card column 2 is punched non-zero if it is desired to execute SPECPN.

The appropriate column is punched zero or left blank if it is desired to skip execution of either program. The standard input decks follow this card, with no separation between BLKGEN and SPECPN inputs, if both are being run. The output will be identical to that of the 7094 version, with the exception of a punched BLOCK DATA.

APPENDIX A

BLOCK DATA GENERATOR PROGRAM

(BLKGEN)

User's Guide

I. History:

Because many large programs use COMMON quite extensively, it has become a common practice to set up all the variables of a program, equate them to blocks, and put all the blocks in a COMMON array. In order to use the variables in a subroutine, one would have to write COMMON, DIMENSION, and EQUIVALENCE cards for each variable. It soon became apparent that it would be desirable to be able to generate these COMMON, DIMENSION, and EQUIVALENCE statements by some external means. The Specification Statement Punch Program (SPECPN) fulfills this desirability, but it requires a rather complicated BLOCK DATA sub-program to be written by the user to describe all the variables in COMMON.

The BIKGEN program was written to generate this BIOCK DATA sub-program from input cards which are easily written and changed. The combination of the BIKGEN and SPECPN programs allow an easy way to create and update a master COMMON of blocks and variables. By using these two programs, it should be fairly easy for one to generate the COMMON, DIMENSION, and EQUIVALENCE cards for each subroutine.

T

II. Usage:

For a picture of the organisation and the usage of the BIKGEN and SPECPN programs, look at Section V. It can be seen that the usage of the two programs requires two passes on the computer. On the first pass, the master input cards are input to the BIKGEN program. The output of the BIKGEN program is the BLOCK DATA sub-program punched on cards. The BLOCK DATA sub-program is input with the variable names for each subroutine to the SPECPN program on the second pass. The second pass output are the COMMON, DIMENSION, and EQUIVALENCE cards which are directly placed into the respective subroutines.

Since the specific usage of the SPECPN program is given in the SPECPN User's Guide, the only additional required information is the format of the input cards to the BLKGEN program. There are nine different cards accepted as input to the BLKGEN program, and each is described below:

1. IDENT Card:

The IDENT card is always the first card input to a run. The word IDENT starts in c.c. 1 and the number of cards that are to follow the IDENT card to describe the job is punched in c.c. 30. If c.c. 30 contains a 3, then there are three cards which contain information describing a run.

THIS IS A SAMPLE RUN

The information punched on the card(s) following IDENT appears as comments in the BLOCK DATA program generated by BIKGEN. Columns 1-71 may be used for the comments cards.

2. PROGRAMMER Card:

The PROGRAMMER card simply contains identification information concerning the programmer, and it is always the second control card in a run following IDENT and the comment cards specified by IDENT. The word PROGRAMMER starts in c.c. 1, and the programmer's name follows immediately after (one space is skipped). Up to 24 characters may be used for the PROGRAMMER name.

Example:

c.c. 1

c.c. 12

PROGRAMMER

J. Gerry Purdy

3. DATE Card:

The DATE card must always be the third control card in any run. The word DATE starts in c.c. 1, followed by a blank, followed by the date.

Example:

c.c. 1

c.c.

DATE

November, 1966

Following the IDENT, PROGRAMMER, and DATE control cards are the cards which actually describe the CONTON blocks of the user's program. Fach COMMON block is described separately in the following way:

- a) The actual cards which define the COMMON block of interest are presented to BLKCEN.
- b) Each master variable name of interest from the above defined COMMON block is denoted followed by a series of control cards identifying the variables within the master variable, their dimension, and their relative position within the block.
- c) After all master variables have been described a signal is given (ENDCOM) and the next COMMON block is defined. Following the last COMMON block definition a signal is given (ENDJOB) terminating the job. Each control card will now be described.

4. COMMON Card:

The COMMON control card must be the first card of each COMMON set. The number of cards that are to follow is placed in c.c. 30. What follows is the card or cards which define the COMMON block exactly as they would be punched for the user's program.

Amaple:

c.c. 1

c.c. 30

COMMON

2

COMMON/VSTR/BLK(50), B(6), 20(36)

In this example, cards are used to define the COMMON block VSTR. BLKGEN constructs a card image of these COMMON statements and places it in the FMT array in the output BLOCK DATA cards for processing by SPECPN.

Only 1 COPMON block name (e.g. VSTR) may be defined per use of COPMON. Subsequent COPMON entries would be used if the user has more than 1 COPMON block in his program. Blank or labeled COPMON blocks are acceptable. A maximum of 9 cards may be used for each COPMON block definition.

5. M Card:

The M card identifies the block name under the current COMMON. The M is placed in c.c. 1, the block name (up to 6 characters) starts in c.c. 10, and the description of the block (up to 24 characters) starts in c.c. 40.

Example:

c.c. 1

c.c. 10

c.c. 40

M

BIKL

FLOATING CONSTANTS

Sets of M and subsequent V cards may be repeated for each block in the current COMMON. The order in which the blocks are processed from the COMMON cards is arbitrary and the descriptions given starting in c.c. 40 are optional.

6. V Card:

The V card is the variable card and contains information about the variable which is contained within the current block. The V is in c.c. 1, the variable name (up to 6 characters) starts in c.c. 10, the dimension, if any, ends in c.c. 30, and the description of the variable (up to 24 characters) starts in c.c. 40, (optional). Singly dimensioned variables are indicated by placing a "1" or blank in c.c. 30.

Emple:

c.e. 1 e.c. 10 c.c. 30 c.c. 40

V CCMR 10 GM RATIO OF E, M, S, V, M, S, J, TO EARTH

7. JUMP Card:

The JUMP card allows spaces to be skipped in the current block for perhaps future expansion. The word JUMP begins in c.c. 1 and the number of spaces to be skipped ends in c.c. 30.

Example:

c.c. 1

c.c. 30

JUMP

20

The above card would cause a "hole" of 20 cells to be made in the current COMMON block.

8. EDCOM Card:

The ENDCOM Card is simply a signal to the program that the current COMMON block is finished. The ENDCOM starts in c.c. 1.

Example:

a.c. 1

ENDCOM

Following the ENDCOM card is either a new COMMON card or the ENDJOB card.

9. ENDJOB Card:

The ENDJOB card is simply a signal to the program that the inputs are finished. It is always the last card in a job.

Example:

c.c. 1

ENDJOB

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III. Sample Inputs:

On the following pages is a listing of a sample set of input cards to the BIKGEN program. No labeled COMMON was used in this case, although both labeled and blank COMMON will work.

MAKE	PSN	UIMENSION SIZE T	DEFINITION	BLOCK
	202		and the same of th	COMMB3
	232	.		RISCOT
	203		The state of the s	COSTIBI
	201			CONNEC
	4			010681
	45			010681
	530	16,4		DATABE
~	2401			LINSIG
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XANR	21			S S S S S S S S S S S S S S S S S S S
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XAVOID	91			
F0P	22	d ·		
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XPAKMT	242			
	1402	1000		
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	20			1800
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XPPTT	285			
XPPT	284			VEC NET
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XIAR	312	23		CONTRA
XTAU	~			OBSTAB
	240			MINCH
	24.1			
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Figure 7-2. Cross-reference of Common Variables (Sheet 16)...

VARIABLE Name	COMMON	OIMENSION Size I		BLOCK
VZFREN ZDEPL Zemg	1		MOLLINIA	USIBBE
2ETA 2TAU 2STAU	60 83			01.068L 01.068L 0857A8
11	184			COMMB3
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		Pigure 7-2		

CONHON VARIABLES IN ALPHABETICAL ORDER

Pigure 7-2. Cross-reference of Common Variables (Sheet 17)

•	CLERLAY(7,0) OVERLAY(9,0) ALSUB7 ALSUB7 CMREAD CMREAD CACYIN CACYIN CACYIN CACYIN RCKEAD FFCVCN FFCVCN FFCVCN SOC SOC SOC SOC SOC SOC SOC SOC SOC SOC	231,675
	CLERLAY(7,0) CLSUB7 CLS	213,501
J Words	SVERLAGIGGOLSURG ARAS ARPTI ARPTI FALOC LETH WEXTC OBJ PPOTPK FISH PTOTPK SI	225,407
11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1VFFLAY(5,4) 2LSUBS CCO DLOGIC FLY31 DLOGG DLOGG DLOGG DLOGG DLOGG DLOGG DLOGG DLOGG DLOGG DLOGG DLOGG	216.660 216.660
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	VERLAY (2.0) VERLAY(3, OLSUS) OLSUSO	216,346
		224.303

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Figure 7.3, Overlay Structure (1 Page)

	. The ISP PROGRAM.	BLKZ (53), BLK3 (9 (7		FLOATING POINT CONSTANTS	POLAR RADIUS OF EARTH	ELLIPTICITY OF EARTH GRAVITATION CONSTANT OF FARTH	-	GM RATIO OF E.M.S.V.M.J.S TO EARTH	RADIUS OF E.M.S.V.M.J.S TO EARTH	EARTH RADII PER ASTRONOMICAL UNIT	NITIAL	CONDITION TIME PER MINUTE	AL CONDITION	TERM. COND. OUTPUT TIME PER MINUTE	SPEED OF LIGHT	EARTH RADI		R MONTH	DEGREES PER RADIAN	/2	10	ZAPI MAXIMIM CAEDOTOR ROD ABA	MINIMUM STEPSIZE FOR TRAJ	UXILIARY PARAMETER FOR TRAJ	TERM USED TO CAL. RADIUS OF EARTH		MOACT PARAMETER	
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Sample Output:

On the following pages is a listing of the outputs of the BIKGEN

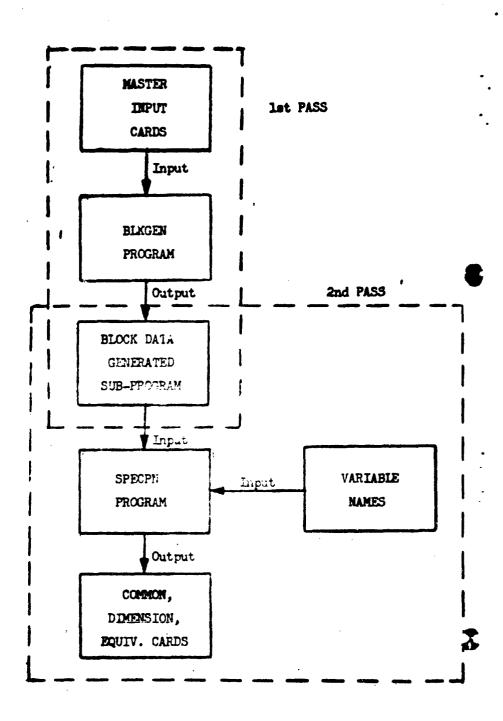
WASTEL COMMON LISTING

CUMMON 3LKI (125), BLK2 (50), BLK3 (150), BLK4 (56) 1, bLK5 (50), BLK8 (200), BLK7 (200), BLK8 (500), BLK9 (75) 2, bLK10 (200), BLK12 (200), bLK13 (50), BLK14 (200) 3, BLK15 (30.) CURRENT COMMON 15 --

Ol FLUATING PUINT CONSTANTS CURRENT BLUCK IS BLK!

DESCRIPTION	EQUATURIAL RADIUS UF EARTH	FULAN MALIUS OF EARTH	CLLIPTICITY OF EARTH	GARVITATION CONSTANT OF EARTH	RUTAT ICHAL KATE OF EXATE	GA RATIO OF COMOSON SOLON TO CARTE	ANDION OF E.H. S. V. H. J. S. TO FARTE	FINE WINDSTEING WIN TITES FLETCH	FORT AR FEATH GALL	INTERPORTED TO SERVICE PROPERTY CANALIT	TATAL CONTINUE TEST OF STREET	TEAM STATE CONTRACTOR OF THE STATE OF THE ST	TERM. COND. DUTPUT TIME PER MINUTE	SPEED OF LIGHT	NAUTICAL MILES PER EARTH MADII	KILUMETERS PER EARTH FACTI	CON SULTANT LEFT TO SULTANT CONTRACTOR	DAYS YER MUNTH IN NEW YEAR	
TYPE																			
POSITION		7	~	•	:0	٥	97	25	7.7	£.7	6.7	36	31	32	73	*	35	36	ъ †
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V. Openisation and Usage of BLEGEN and SPECPN Flow Chart:



VI. References:

 Specification Statement Punch Program (SPECPN) User's Guide,
 A. J. DeSalvio and J. Rau, September 15, 1966, CDRC Report Number 3127.21-01. APPENDIX B

SPECIFICATION STATEMENT PUNCH PROGRAM

(SPECPN)

User's Guide

SPECPN USERS GUIDE

The SPECPN (SPFCification statement Pullch) program was written to aid the FORTRAN programmer in his preparation of COMMON, DIMENSION, and EQUIVALENCE statements. It was designed primarily for programs which use the philosophy of master COMMON blocks and EQUIVALENCE variables e.g.

COMMON/COMMAM/BIRI (100), BIR2 (5000)

EQUIVALENCE (BIEL (26), NARL), (BIEL (63), VARL)

In this example only the variables VARI, VARI are needed from the 100 cell block HIMI and the pole cell block BLK2. Using EQUIVALENCE statements to identify only those variables actually used in a subroutine significantly reduces the card volume for a subroutine and the size of the symbol table necessary at compile time. This technique is opposed to the standard one of stringing out the actual COMMON variable names in the COMMON statement e.g.

COMMON/COMMUM/ A, F, C(3), E, E, E(16), G(2), VAR1

DATA subprogram must be prepared out. The substitute in COMMON, EQUIVALENCE numbers, and DESTRUCT and The Street of the Street and COMMON, EQUIVALENCE numbers, and DESTRUCT and The STRUCT A subprogram is then compiled and similated as part of the STRUCT and the COMMON map changes, the STRUCT as data cards specifying by subroutine those ward then defined in COMMON. These variables may be in blank COMMON or any of the laceled COMMON blocks defined in the ELOCK DATA subprogram. The output from SPECIAL is the COMMON, and EQUIVALENCE statements necessary for each subroutine.

The advantages of using SPECPN are several:

- a) The format of the punched cards is uniform. This makes the program listing neat and easy to read.
- b) Once the BLOCK DATA subprogram has been verified for accuracy, the worry of mis-equivalencing a COMMON variable is ended.
- c) If significant changes are made in the COMMON map of a large scale program such that the equivalence numbers are disturbed, only the BLOCK DATA subprogram need be re-keypunched. The data cards used with the old COMMON may be re-submitted with SPECPN to recover all the COMMON, DIMENSION, and EQUIVALENCE statements for the new COMMON map.

BLOCK DATA Input to SPECPN

The BLOCK DATA subprogram must contain the following four labeled COMMON blocks:

COMMON/ISIZE/ISIZE

COMMON/BLK /BLK(I)

COMMON/FMT /FMT(J)

COMMON/XMCOM/XMCOM(ISIZE)

COMMON/ISIZE/ISIZE

ISIZE is an integer which defines the size of XMCOM. ISIZE will be 3 * N, where N is the total number of COMMON variables defined in the users program.

COMMON/BLK /BLK(I)

BLK is a dimensioned array which contains the name of each <u>master</u> COMMON block in BCD. The order of the names within BLK is arbitrary. If the following COMMON statements appeared in the user's program:

COMMON / BLK1(100), BLK2(5000)

COMMON/COMA/ABLK1(50), ABLK2(25), ABLK3(500)

the master COMMON block names BLK1, BLK2, ABIK1, ABIK2, ABIK3 must appear in BLK, left adjusted, in BCD. For example:

COMMON /BLK/BLK(5)
DATA (BLK(I) • I = 1 • 5) /6HABLK2 • 6HBLK1 • 6HABLK3 • 16HBLK2 • 6HABLK1 /

could be used to define /BLK/ for this program. The labeled COMMON block names, i.e. COMA, are not specified within BLK.

COMMON / FMT / FMT(J)

pmT is a dimensioned array defining the COMMON statements that appear in the user's program. All the information in FMT is in BCD. Since the format of a COMMON statement is so arbitrary (is it blank COMMON, or labeled COMMON; how many variables etc.) and the elements of the card so variable, the user is required to store in FMT the actual FORMAT statement that would cause the COMMON statements defined in the users program to be punched. For example; the COMMON card

COMMON /COMMAN / BLK1(100), BLK2(5000)

could be punched with the following statements

WRITE (12, 901)

901 FORMATI6X+34HC(MMON/COMNAM/BLK1(100)+BLK2(5000))

What goes into the array EMT is exactly what the compiler would generate in core at location / .D.: the BCD equivalent of what follows the word FORMAT, each character from " (" to the terminating ")" inclusive. In this example:

COMMON /FMT/FMT(7)

DATA (FMT(I)+!=1+?) /6H(6X+34+6HHCOMMO+
16HN/COMN+6HAM/BEK++H1(100)+6H+dEK2(+6H5000))/

would be used to load the common FMT. Fach COMMON statement is specified in the above manner, in any order within FMT. If the final BCD word for a given format is not a full b characters, fill out the word with blanks following the ") he clare each "FORMAT" must begin in a new word within FMT.

COMMON/XMCOM/XMCOM(ISTE!

XMCOM is an N x 3 array stored singly subscripted by rows.

(N is the total number of COMMON variables in the user's program).

In column 1 of XMCOM is placed the name of each COMMON variable, left adjusted, in BCD. Column 2 of XMCOM contains integer code words of the form I * 10000 + J. I is the entry in BLK which identifies the master COMMON block name appropriate for this variable. J is the equivalence number of the given variable within the master COMMON block. Column 3 of XMCOM contains integer code words of the form

K hickspace hickspace 10000 + L. L is the dimension of the given variable. (Non-dimensioned variables are indicated with L = 1) K is the entry in FMT of the first word of the "FORMAT" statement which identifies the COMMON statement containing the given master COMMON block name. A sample XMCOM will now be constructed from the following COMMON map:

```
COMMON//BLK1(24)
COMMON/COMA/ABLK1(50)
                         (BLK1 (
                                    11,CAE
                                              ) . (ELK1 (
                                                            21.TEMP
EQUIVALENCE
1.(BLK1 ( 12),CBE
                       1-16LK1 (
                                   131 . CDAYMN)
DIMENSION TEMP(10) + CDAYMN(12)
                                                            21.NDPR
                                    1),NPR
                                              ) , (ABLK1 (
EQUIVALENCE
                         (ABLK1 (
             3) *MATRIX)
1. (ABLK1 (
DIMENSION MATRIX (48)
```

To compute ISIZE, we simply count the number of COMMON variables:

CAE, TEMP, CBE, CDAYMI, NPR, NDPR, MATRIX... 7

ISIZE: 3 * 7 = 21

COMMON/ISIZE/ISIZE

DATA ISIZE /21/

The entries in ELE will be the master COMMON block names:

BLK1, ABLK1

COMMCH / BLK / BLK(2)

DATA (BLK(I), I = 2) / OHBLKI , OHABLKI /

The FMT array would be constructed from the following FORMAT statements:

```
FORMATION, HODMHON//BLK1(24))
FORMATION, HIDMMON/COMA/ABLK1(50))
COMMON/FMT//MT(0)
DATA (FMT(1)+1=1+4)/
16H(6X+16+6HHCOMMO+6HN//BLK+6H1(24))/
DATA (FMT(1)+1=5+9)/
16H(6X+21+6H-COMMO+6HN/COMA+6H/ABLK1+6H(50)) /
```

```
MICOM would look as follows:
                                O VARTABLE MANE
                                CO GUE SUTBY
 COMMON/XMCOM/XMCOM(21)
                                @ EGUZVALEUPE NO.
 EQUIVALENCE (XMCOM, IXMCOM)
 DIMENSION IXMCOM(21)
                                THE ENTRY
 DATA (XMCOM(1), I= 1,21) /
                                CO OTHENSTON
16HCAE
        • 10001 • 100Cl •
26HTEMP . 10002, 10010,
36HCBE . 10012. 10001.
46HCDAYMN. 10013. 10012.
56HNPR , 20001, 50001.
66HNDPR . 20002, 50002,
76HMATRIX. 20003. 50048/
```

For compatibility with the G.E. computer, XMCON should be set up as follows:

```
DATA (XMCOM(1), != 1.21,3) /6HCAE ,6HTEMP ,6HCBE ,6HCDAYMN
1.6HNPR ,6HNDPR ,6HM4TP1X/
DATA ((IXMCOM(1), IXMCOM(1-1)), != 2.20.3)/
1 10001, 10001,
2 10002, 10010,
3 10012, 10001,
4 10013, 10012,
5 20001, 50001,
6 20002, 50002,
7 20003, 50048/
```

PATA CARD Input to SPECIAL

The BLOCK DATA subpresses described above contains the complete definition of each COMMIN to be in the users program. The remaining inputs to SPECPN are a serie, of fixed format data cards describing the individual COMMON variables defined in each subroutine in the users program. The data cards have the following format:

For each subroutine:

Card 1

Contains the suproutine name in columns 1 - 6.

This card serves to identify the routine which the runched and printed output from SPECPN belongs.

The name punched in cc 1 - 6 may be any combination of alphanumeric characters except ENDSUB or ENDJOB.

Carde 2-(N - 1) Contains the COMMON variable mames, punched up to 12 per card, in columns 1 - 6, 7 - 12, 13 - 18, etc.

The variable names must be left adjusted in each field.

Card N Contains ENDSUB in columns 1 - 6. The entry ENDSUB indicates to SPECPN that all the variables for this subroutine have been entered. Columns 7 - 72 of this card are ignored.

The above series of cards are repeated for as many subroutines as desired. Following the final ENDSUB card must be placed a card with ENDJOB to indicate the end of the input data. See figure 1 and appendix for an example of the deck set-up and data card samples.

Output from SPECPN

SPECPN delivers both printed and punched output. The first block of printed output will be the XMCOM array after having been algebraically sorted about column 1. For each subroutine name card in the data deck, a message is printed stating:

THE FOLLOWING CARDS ARE FOR SUBROUTINE XXXXXX

This card is also punched. Next will be the EQUIVALENCE, DIMENSION, and COMMON cards, in that order. Continuation cards are indicated with an E in column 6 for EQUIVALENCE and a D in column 6 for DIMENSION. A card image is printed and punched. In the event that a variable is requested in the data deck that does not appear in XMCOM, the following error message is printed only:

ERROR - XXXXXXX NOT IN XMCOM.

Operating Notes

One point that should be noted is the flexibility which results from the use of the FMT array in the BLOCK DATA subprogram. As was explained above, SPECPN simply executes a WRITE (12, FMT(I)) in order to punch the Ith COMMON statement. In theory then, the user can direct

subreutine. For instance the user could place in FMT the necessary control characters to cause comments cards to be punched before or after COMMON statements, which define the variables in that COMMON block. Another use of FMT might be to include DIMENSION card images for those variables which are multi-dimensioned in the user's program since there is no provision in XMCOM for indicating such.

This could be accomplished as follows:

- a) Place in FMT(J) the FORMAT statement that would cause the desired DIMENSION statement to be punched.
- b) In the appropriate column 3 entry in LXMCOM, set the dimension of the multi-dimensioned variable to 1.
- c) Instead of pointing to the COMMON card image in FMT for this variable, point to the DIMENSION card image, J.
- d) Be sure that another variable in the subroutine list does point to the proper COMMON card image.

Setting the dimension to 1 will suppress the punching of a standard DIMENSION card.

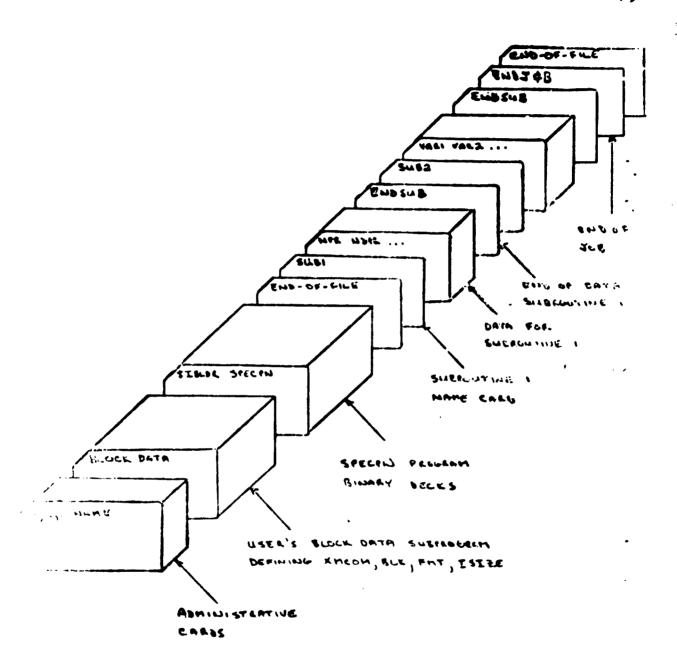
To aid the spot checking of EQUIVALENCE variables it is a go d practice to list the variables in ascending EQUIVALENCE order on the data decide for each subroutine. If it is desired to obtain EQUIVALENCE what may master COMMON block, that is, have SPECPN start with a new of TOMMON block and for each new master COMMON block, it is only necessary to beak up the variables by COMMON block within a subroutine and submit each set under the name of the same subroutine. The fact that the subroutine name is repeated within the data deck is immaterial since it is used only for identification of the output.

The following restrictions should be observed when running SPECPN:

a) The total size of XMCOM + BLK + FMT must not exceed 22,753₁₀ cells. This is based on the SPECPN version currently in use on the 7094.

- b) Do not use a subroutine eard with EMDSUB or EMDJOB in columns 1 - 6. These variables may appear on a data card providing they are not placed in columns 1 - 6.
- c) No variable name may be repeated in XMCOM.
- d) When operating on the 7094, a PUNCH card should be included in the administrative cards if more than 500 punched cards are expected or if it is desired to have the punched cards listed and/or interpreted.

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The following page is an example of the data card input to SPECPN

FADK ZXA FADK ZXA AAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAD LAVA AAAAAD LAVA AAAAAD LAVA AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	FIRST										4	(
THUMP DAY KUFK INT UMP ORB BOG DRY KLT SPOT FLY RADE ZXA AAAD LAVA SPOT KLT INT FADK ZOT FLY NGN MPTONB DIP AGG LAVA ZXA BBNFK ORB CHTP CAGOM TWY NPP BUM DOG BNFK ORB CHTP CAGOM TWY NPP BUM DOG BNFK CNB CHTP CAGOM TWY NPP BUM DOG BNFK FLY ECN STG LLAE AZHDT ATHUMB BLKK FLY ECN SHT DOT ECND TO THE AGAS CAAN NPF AGAS CAAPIN FLY ELY LOT COM NPF AGAS CAAPIN FLY FLY LAND	CAE	ACT	410	KLT		201	K Q K	I O	Z 0 Z	O X	Q I	TNS
DOG DRV KUFK INT UMP ORB HLT BLKK UVW KZY FLY FADK ZXA AAAD LAVA SPÖT SPÖT SPÖT SPÖT SPÖT SPÖT SPÖT SPÖT	KNT			THUMB								KKK
HLT BLKK UVW KZY SPÖT		NOCE	MNO	900		KUFK	121	Š		0 % O		ک
SPOT KLT INT FADK ZOT FLY NON NPTONE SPOT TORB DIP AAAD RTS OKL AGGG LAVA ZXA BBNFK ORB CNTP CRUCH CO CAEM CTS KLRSS NAN BOND TNS CODE RTS STOL LUAE AZENT MTHUNE BLKK FLY GGG BRT COM NPF AEAB SUAYING BNFK ACT FLY COM NPF AEAB SUAYING FLY TOWN LOT COM NPF AEAB SUAYING FLY TOWN ZOT KKK DRV	ONTL	0000	NOO	H_1								;
SPÖT KLT INT FADK ZOT FLY NON NPTONB CHOR SENT TORB DIP AAAD RTS OKL AGGG LAVA ZXA BBNFK ORB CNTP CARON TVV NPP RUM DOG NAVO NPP RUM DOG CAEM CTS KLRSS NAV BOND TNS CDCP RTS STOL LUAE AZENT ATHOWS BLKK FLY EGN HET DOT EGND PT NPR ACT FLY EGN HET DOT EGND TO NPR ACT FLY LUAE AZENT ATHOWS BLKK FLY CON NPF AEAB STAYMS FLY CON ABAB DNK ZOT KKK DRV	ZZZ	AROUS	AKO	300		FL	FADK	ZXA				2
SPOT KLT INT FADK ZOT FLV NON MPTONE DHY FDP AMLT TORB DIP AAAD RTS OKL AGGG LAVA ZXA BBNFK ORB CNTP FARENCE CAEM THE RUNG ORB CNTP FARENCE CAEM THE RUNG BOND THE COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB SHAPING BHFK ACT FUN LUF COM NPF AEAB BNK ZOT KKK DRV	KNOLM	ANT	:	SPOT		:		AAAD	LAVA			
SPOT KLT INT FADK ZOT FLY NON MP UMP XOLT KZY DRV NDPR OPT FDP AHLT TORB DIP AAAD RTS OKL AGGG LAVA ZXA BRNFK ORB CNTP CCROM CVV NPP RUM DOG BOND TAS DDCP RTS STGL LCAE AZWOT NTHUMF BLKY FLY DGN NPP AEAB SDAYM FLY LAND KUFK DIP ABAB DNK ZOT KKK DRV	ENDSU	•										
SPOT KLT INT FADK 201 PLY NGW MET TORB DIP AAAD RTS OKL AGGG LAVA 2XA BBNFK ORB CNTP COON TOWN NPD RUM DOG NOT STOLL LAE A 2807 3TH UNE BOND THS OND NTS STOLL LAE A 2807 3TH UNE BUNK FLY EGN NPF AFAB SUAYMN FLY KUFK DIP ABAB DNK 201 KKK DRV	SECON	֓֞֝֜֝֝֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֡֓֓֓֡֓֓֓֡֓֜֝֡֓֡֓֡֓֡֓		1	i			(i			74 :4
UMP XOLT KZY DRV NDPR OPT FDP AMLT TORB DIP AAAD RTS OKL AGGG LAVA ZXA BBNFK ORB CNTP CRICM CVV NPC RUM DOG MOUSE CELLIPABAL CQQ CAEM CVG KLRSS NAN BLKK FLY EGN BRT STCL LCAE AZWHT NTHUWE BLKK FLY EGN BRT STCL LCAE AZWHT NTHUWE BRKK FLY EGN BRT STCL LCAE AZWHT NTHUWE BRKK FLY EGN BRT STCL LCAE AZWHT NTHUWE BRKK FLY EGN BRT STCL LCAE AZWHT NTHUWE BRKK FLY LOND RTS STCL LCAE AZWHT NTHUWE BRKK ACT FON LUF GDM NPF AFAB SUAYHN FLY LAND KUFK DIP ABAB DNK ZOT KKK DRV	COAYR	NAGAB	DAK	SPOT	7	LNI	FADK	2 01	7	ZOZ		DLKK
TORB DIP AAAD RTS OKL AGGG LAVA ZXA BBNFK ORB CNTP CCROM CVV MPP RUM DOG MOUSE CELLIPABAE 400 CAEM CTS KERSS NAV BOND TNS DDDP RTS STOL LUAE AZENT ATHUNE BLKK FLY UGN NET DOT EGND OPT NPR BNFK ACT CUT CDM NPP AEAB CAYMA FLY KUFK DIP ABAB DNK ZOT KKK DRV	360	DALP	2	Q D	XOL T	KZY	ORV V	Z Q D	9	F 00		8 05
BBNFK ORB CNTP CGIOM TVV NPP RUM DOG MOUSE CELLIPABAE 400 CJEM CTO KLAE AZMOT ATHUME BLKY FLY EGN NOT EGN NPF AEAB COAYM BNFK ACT FUN LUT GOM NPF AEAB COAYM FLY KUFK DIP ABAB DNK ZOT KKK DRV	רכא	a NO	ž	TORB	910	AAAD	RTS	OKL	A 666	LAVA		KNT
MOUSE CELLIPABAE 400 CAEM C'S KLR5S NAN BOND TAS DDCP RTS STOL LUAE AZMPT ATHOWS BLKK FLY EGN HET JOT EGN NPF AEAS COAYM FLY KUFK DIP ABAB DNK ZOT KKK DRV	100	ACT	KKK	BBNFK	ORB	C 1 2	WOTERL	^	o di	AU M		0 48
BOND THS COCO RTS STOL LUAE AZMPT ATHOMS BLKK FLY EGA BET JOT EGNO OPT MPR BHFK ACT FUN LUT GOM NPP AEAS COAMM FLY KUFK DIP ABAB DNK ZOT KKK DRV	KUFK	æ	ZMPT	MOUSE	CELLI	PABAL	000	を出てい		KL255		そい
BLKK FLY EGN NOT EGNO OPT BMFK ACT FUN LOT COM NPP AEAB FLY KUFK DIP ABAB DNK ZOT KKK DRV	OINK	XUFK	DON	BOND	7NS	COCO	6) F	10.4%	1 VE	Ldiv2 "		D'ELT'O
BHFK ACT FUN LOT COM NPF AEAB FLY KUFK DIP ABAB DNK ZOT KKK DRV	XOL T	00	N O	27.75	کر لیا	ر د	j.	50	CZUS	<u>.</u>		:: ::
FLY LAND KUFK DIP ABAB DNK 207 KKK	, K	Q.	* X	Brifk	PC1		ر. در	どう	NPF	4643		いてトスマ
FLY LAND KUFK DIP ABAB DNK 20T KKK	ENDSU	æ										•
KUFK BOTO ABAB DNK 201 KKK	THIRD											
KUFK DIP ABAB DNK 20T KKK	CELL I	FCDAYM	NKKK	FLY				LAND				
KUFK DIP ABAB DNK 20T KKK	ENDSU	•										
KUFK DIP ABAB DNK 20T KKK	FOURT	I				•						
KUFK DIP ABAB DNK 20T KKK	ACT	g										
KUFK FLY BOT DIP ABAB DNK 207 KKK	ENDSU	.										
KUFK FLY BOT DIP ABAB DNK 20T KKK	FIFTE											
KUFK FLY DOT DIP ABAB DNK 207 KKK	CA1										•	
KUFK FLY BOT DIP ABAB DNK 20T KKK	ENDSU	60										
FLY BOT DIP ABAB DNK 20T KKK	SIXTH		٠									
FLY DOT DIP ABAB DNK 20T KKK	7		•	X							•	
PLY DOT DIP ABAB DNK 20T KKK	ENDSU						٠					
ENDSUB END JOB	K00	FLY	100	910	ABAB		2 07	X X	S			
	ENDSC											

The following pages illustrate the punch card output from SPECPN

231.AC1 1	-,	10 EC W 1	6) • MP	241 . THUMP 1	11,000	_	171.CK 1	-	250 NNN 0	2) oK2Y	Ξ	8) · LAVA		(2) ^2			191900181581			61.ABAB 1	1910KLT 1	_	_	-	2) • x0LT)	~	-	~	710RTS	_	W ORKTA	A SONON OF	11.80%) • XUFK	-	=	251 - N.IN .	1 POGN
) • (BLK	1219144 - 1 -	1, (BLK6 (1. LARTIO	1.18LK3 (1. BLK4 (1.(BLK5 (1. (3LK6 (1. (DOPLA () • (COLB (1, :8LK3 (~) • (DCPLR (< 6) • DRV	_				ECOND), (BLK		1 ACTION) CARTION	10 (TJA (1. (BLK6 (1.(BLK2 (1. COOPLR (1. (BLK4 (2 0 TOD 1 C	1,18173 () • (OLK6 (), (BLK1 (1.18LK6 (1.18LK6 (1.(BLK1 (10 (7.JA .	3	1, idoola (
	=	11,478	-	_	151,50aR	-	910 · 15	-	=	-	1111 FADK	31.AAAD		(4) SKKK			4(1) , BLK5(2) , BLK6(TINE	101.CDA	261 SPOT	1	26) • NON	_	-	_	-	-	_	2	23) ACT	3) • CN 10	11. APP	SIPDAB	35004118	1:	22) FKLR55	というだちにの
) • (=[K6 [1 + (31.52 (1, (C) 18 (1, (823)), (ELK6 (1, (3LK5 () , (86.44 (1. (TRAJ () , (BLK7 (1 COLB (1. IBLK4 T	1 . (BLK2 (1	102.19	_	[6]	12	12 (19 9) 90 (19)	FOR SURR		1. (BLK3 (1. (BLK4 (1.(0068	1.(BLK1 (1. (31.K5 () • (F;ZA () OTRAJ (1. (BLK6) • (BLK2 () • (8LK3 () SULKS	1.17.JA) , (M.Z.A. i) - (B.K.	1.(85.44	1,(00:8	1, ((.LB (1 (8, 26
2. 2. 3. 4.	_	102019	~		1110KKK	_	_		21.	8) • UKV	-	-	11.00M	910	>> 0.€	BLK1(10).BLK2	AH/M2A (26) . BL	1.451 AGT. 0001			! ~	-	1110FLY	_	-	_	_	41.KJJ	-	BIOLAVA	-	1 91.0AB	^	11.000	_	_	. j_	42.00kg
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